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The gross anatomy of Corizus lateralis (Say) (Hemiptera, Corizidae)

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THE GROSS ANATOMY OF CORIZUS LATERALIS (SAY) (HEMIPTERA, CORIZIDAE)

BY

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INTRODUCTION

Corizus lateralis is a small Hemipteron, approximately 7.5 mm. in length. Gibson (1919) explained that there were no outstanding features which would readily serve to separate it from the others of the family. He recommended the elimination method, "If it doesn't fit any other species description — place it in lateralis." Color was of little use in identification since insects were collected in shades of brown, tan, pink, light yellow and pale green, with occasionally one of mottled appearance.

Blatchley (1926) gave the following description:

> "Elongate-oval, depressed above, convex beneath. Pale dull yellow, often strongly suffused with reddish; antennae tinged with fuscous, the basal joint with one or two black lines; a small blackish spot behind each eye, a faint one on humeri and some fuscous dots on nerves of corium usually present; membrane clear hyaline, surpassing abdomen; connexivum yellow, rarely with a faint dark spot near the front angles of each segment; dorsum pale, black at base, second segment with median black spot, third, fourth and fifth each with three or four smaller rounded or curved black spots, sixth with a median black stripe, these darker spots or stripes often reddish-brown; under surface usually uniform reddish yellow with sternum black at middle, rarely with sides of abdomen reddish brown; legs yellow with black dots. Antennae with basal joint reaching apex of head, 2-4 subequal. Ocellar tubercles prominent. Pronotum relatively short, feebly declivent, disk finely and densely punctate, the transverse impression reaching the margins, the median line obvious, but very fine. Scutellum constricted near apical third, coarsely not densely punctate, its edges raised and apex sub-acute. Abdomen but slightly wider than pronotum, its margins subparallel; connexivum narrowly or not at all exposed. Sixth dorsal of female broadly triangular with apex rounded; of male somewhat prolonged, subspatulate. Length, 5-7.5 mm.; width, 2-5 mm."

Corizus lateralis is found in many localities of the United States (Hambleton, 1908) and in the temperate and tropical regions of several foreign countries. Distant (1881) listed this species in Central America and published an excellent colored drawing of it and Corizus hyalinus Fabr.

Gibson (1919) said, "Corizus lateralis occurs all over the United States and southward."

Blatchley (1926) gave the habitat as follows: "New England west to Colorado, south and south west to Florida, Texas, Arizona, and Mexico." He stated that in the spring it occurred on red bud (Cercis canadensis L.) distributed along borders of thickets and in the open woods, while in the late summer and early fall it was found on weeds and grasses of timothy meadows and waste places.

In an excellent life history of this insect, Hambleton (1909) declared that smart weed (Polygonum pennsylvanicum L.) was the native plant food.

The writer found that a greater number of the insects could be collected from smart weed than from any other plant. This plant is an annual which thrives in moist sandy soil, and is usually found in great profusion along the flat areas of creek banks that are covered with water during the rainy seasons. Corizus lateralis was collected in greater numbers in the fall when the plant was beginning to produce seeds. At almost any period of the day the insects could be seen piercing

the stems and seeds with their beaks.

In Tennessee the insects were collected by sweeping blue grass, corn, and smart weed. Throughout the winter the insects lived in cages at room temperature, with young corn seedlings as their only food. During this period mating was frequently observed. The eggs were attached by means of slender stalks to the top and sides of the cages and to the under side of the corn leaves.

Corizus lateralis continues to inhabit the smart weed for about a week following the first killing frosts. From this period on, the insects hibernate as adults in the bases of clumps of grass, among leaves, and a few are found under loose bark. Some were collected by placing grass clumps, including the roots and adhering soil, into large tin funnels. As the debris dried, the insects crawled down through the neck of the funnel into a glass jar, where they were removed to rearing cages.

METHODS

Corizus lateralis is rather small and therefore all drawings and observations necessitated the use of a microscope. For the gross anatomy a binocular dissecting microscope was best, while a compound microscope was used for the more minute detail. A ruled ocular micrometer disc was used for measuring.

Dissections

Most of the dissections were made after imbedding the insects just beneath the surface of molten beeswax in a Syracuse watch glass. This held the body firmly during the procedure. Micro-scalpels were used to carve away portions of the hardened wax and expose the part to be studied. Dissections of freshly killed insects were kept covered with a physiological saline solution so that a more normal appearance of the tissues could be viewed.

Micro-scalpels were improvised by breaking thin safety razor blades into angular fragments. The more suitable sharp pointed pieces were soaked in carbon tetrachloride for a few minutes to remove the coating of oil from the surface. The pieces were cemented to metal handles by means of "Liquid Solder", a metallic cement available at most ten-cent stores. The metal handles were discarbed dental scrapers and probes,

selected according to the shape and curvature of the scraping end.

Micro-needles were made from "minuten" insect pins cemented to the dental scrapers as described above. These tiny needles were ground to a fine tip on a smooth-grained razor hone.

Within a few hours after being used in saline solution the dissecting tools rusted very badly. As a preventative, the points were dipped into an oil or petroleum jelly before putting them away.

The softer parts of the viscera were hardened by placing the whole insect in boiling water for approximately fifteen minutes. The coagulation produced in this manner caused the internal organs to retain their normal shapes when removed from the surrounding body wall. A comparison of these boiled organs with the normal living tissues showed very little difference in size and shape. This difference was so imperceptible that it did not interfere in the gross dissection.

When a dissection showed the internal organs very clearly, suitable drawings and notes were made. The wax matrix was then removed and the specimen was preserved in a tiny individual vial of seventy per cent alcohol. An accurate record was kept of these vials and their contents.

Sectioning

Observations of minute details of the internal organs were facilitated by means of serial sections. These were made with the n-butyl alcohol method (Becker and Roudabush, 1935). The insects were fixed in Gilson's fixing fluid, soaked in iodine alcohol, and were then placed in the following solutions:

1. 70%, 50%, 35% ethyl alcohol, at least thirty minutes in each.
2. 90 cc. 50% ethyl and 10 cc. n-butyl alcohol - 2 hours.
3. 80 cc. 70% ethyl and 20 cc. n-butyl alcohol - 2 hours.
4. 65 cc. 83% ethyl and 35 cc. n-butyl alcohol - 4 hours.
5. 45 cc. 95% ethyl and 55 cc. n-butyl alcohol - 6-48 hours.
6. 25 cc. 100% ethyl and 75 cc. n-butyl alcohol - 3-12 hours.
7. A fresh solution of number 6.
8. N-butyl alcohol 100%, two changes in a course of 3-4 hours or longer.
9. Paraffin (56° to 58°C.) two parts and n-butyl alcohol 100%, one part in covered dish in an oven, for 12 hours.
10. Melted paraffin 56° to 58°C., two to three changes during four to five days.
11. Imbed. Trim closely and soak the block in water for at least two weeks.

Serial sections were made transversely, sagittally, and frontally at ten, twenty, twenty-five and forty micra. Both

males and females were used. A few insects were sectioned so thick that only four to six sections were made of the entire body.

For general morphological structures a thickness of forty micra was more suitable because it was easier to trace the connections of musculature and other structures from one serial section to another.

Some specimens were dehydrated in alcohol, impregnated with melted paraffin, and imbedded in a block of paraffin. Excess wax was trimmed away from the insect, leaving a thin supporting matrix. The whole block was then cut lengthwise, thus dividing the insect into two more or less equal parts. These halves were cleared in xylol and mounted in balsam. This technique rendered them clear enough to be studied as transparencies. Some of these were projected and drawn to show muscle attachments.

Clearing

In order to discern the sclerites it was necessary to clear the insects. The following procedure proved satisfactory. The bodies were first boiled for thirty minutes in ten per cent potassium hydroxide. They were then rinsed in running water, and bleached in ten per cent hydrogen peroxide for approximately four days. After rinsing again in water, the specimens

were cleared in absolute dioxan and mounted in deep cells filled with balsam.

These cells were made by cutting thin strips of celluloid, bending them in a circle, and cementing the overlapping ends with acetone, the depth being determined by the width of the celluloid strips. A drop of acetone was used to glue them securely to microscope slides. The cells were filled with balsam, specimens submerged in the fluid, and warmed cover glasses were sealed to the top by means of hot paraffin of a high melting point.

Whole specimens cleared and mounted in this manner were very transparent. The segments and underlying chitin were easily discernible. Annoying bubbles were prevented from forming in the body by transferring from one liquid to another as quickly as possible.

Great difficulty was encountered when trying to trace the branching of the veins in the membranous part of the fore and hind wings. Unless live specimens were used, liquids would fill the trachae very quickly, rendering them so transparent that they were hard to see.

In an experiment using glycerine jelly, it was discovered that veins could be located easily if the mounting medium touched only one surface of the wings. While making a slide, one wing became completely submerged by jelly, but a large air

bubble was accidentally entrapped between the other wing and the cover glass. The veins in the former could not be seen unless light was adjusted from an angle. In the latter, minute structures appeared in sharp detail since light reflected from the curved sides of the veins and made them appear as very bright streaks.

Using the above method, the remaining wing mounts were made by coating with melted glycerine jelly a small area of the microscope slide and allowing this to cool until nearly hard. The wing was placed flat on the jelly, taking care that neither edge was dipped below the surface of the medium. A cover glass was slowly lowered onto the preparation and was pressed into position with the finger nail. After being cooled to room temperature the hardened preparation could be turned on edge in the microprojector without danger of the cover glass sliding off.

Drawing

Cleared specimens and sections were drawn by the following projection technique.

The compound microscope was clamped in a horizontal position and the mirror removed. A focusing microscope lamp (six volts) was used to obtain a very fine "pencil point" ray.

This bright beam was focused on the substage condenser of the microscope, on through the slide, and then through the barrel of the microscope. At the ocular a silvered prism was placed to turn the rays of the image down on the drawing paper. Using cardboard as a shield, extraneous light was prohibited from striking the paper. Thumbtacks held the drawing paper in position while the structures were sketched lightly with a pencil. Corrections were made in the drawings after regular microscope examination.

This technique proved to be faster than the camera lucida method. Both eyes are used instead of only one, the light may be more easily adjusted, and the minute details traced with greater facility.

Using the microprojector described above, the photomicrographs (Figs. 40-76) were made very quickly and inexpensively. Photographic enlarging paper was used in lieu of the drawing paper. The exposures were made by focusing on a white card board the size of the enlarging paper. The card board was replaced with the photographic paper and the exposures were made by turning on the light for five seconds. All exposures were made in a photographic dark room.

THE STRUCTURES OF THE HEAD

(Pl.I, Figs.1-4; Pl.IV, Fig.16; Pl.VII, Fig.23)

The head is composed of inseparable sclerites, with few outstanding sutures to aid in locating their margins. As in highly developed insects (Snodgrass, 1921, 1928, 1932, 1935), only the general regions of the head capsule can be identified.

A large opening, termed foramen magnum (For, Figs.1,3), leads into the posterior extremity of the head capsule. Through this aperture pass the nerve cord, digestive canal, aorta, salivary glands, and other structures.

Surrounding the foramen magnum dorsally is the occiput (Oc, Figs.1,16), which extends anteriorly to the prominences bearing the compound eyes and ocelli.

Immediately cephalad to the occiput is the vertex (Vx, Figs.1,16), which contains the two ocelli (O, Figs.1,16). The frons (Fr, Figs.1,16) is only slightly separated from the vertex by means of the epistomal suture (es, Fig.1) which represents the internal connections of the tentorium. This suture is composed of one transverse and two longitudinal grooves. Bounded by these grooves, the clypeus (Clp, Figs.1,4,16,23) extends anteriorly to a small transverse fissure, which separates it from the anteclypeal plate (Aclp, Figs.1,16) or tylus, representing the apical portion of the head regions. Beneath the anteclypeal plate is the labrum (Lm, Figs.4,16), a slender

triangular plate which covers the anterior groove of the labium (Lb, Figs.4,16). The mouth parts and their mechanisms are discussed in a separate section of this paper.

Laterally, and in front of the compound eyes (E, Figs.1,4, 16,23) are two areas which are connected with the mandibular and maxillary bristles (MdB, MxB, Fig.3) in the head cavity. The dorsal one is the mandibular plate (A, Figs.1-4,16), which extends forward as far as the anteclypeal region. The maxillary plate (B, Figs.3,4,16) or lorum is lateral to the mandibular plate and is separated from it by means of a deep fissure. A lateral fold of the head capsule extends ventrally on each side of the base of the beak. These folds are known as the bucculae (buc, Figs.4,16).

The genae (Ge, Figs.4,16,23) are the areas immediately beneath each compound eye. Under the head, and behind the basal attachment of the beak, is a sclerotic hypostomal bridge which is known as the gula (Gu, Figs.4,16,23).

Mouth Parts

(Pl.I, Figs.2-4; Pl.II, Figs.5-10; Pl.III, Fig.14)

The beak of Corizus lateralis extends posteriorly to a point between the mesothoracic and metathoracic coxae (Figs. 16,23). During the feeding process the whole beak can be

brought forward until it forms a right angle with the head. Before feeding, the insect appears to feel around for a satisfactory spot, braces its legs and, gradually lowering the head, forces the inner stylets into the plant by means of alternate contractions of the mandibular and maxillary muscles (Weber, 1930, 1933). As the labium bends gradually at the joints, the head almost touches the plant. Complete desheathing of the bristles was not observed in Corizus lateralis. As described by Readio (1928), Corizus hyalinus Fabr. holds the labium parallel with the body while feeding and afterwards uses its front legs to replace the bristles in the labial groove. Extending just beyond the first joint of the beak is a small labrum (Lm, Figs.4,16) which closes the labial groove anteriorly. Beginning with the anteclypeal plate (Aclp, Figs.4,16), the labrum tapers gradually toward its apex, ending in a sharp point. It can be moved separately while the rest of the mouth parts remain still.

There are four segments of approximately equal length in the labium (Lb, Figs.4,16,23). The first or basal segment is slightly thicker than the rest. Many tactile setae (Set, Fig. 14) are located on the apex of the fourth segment.

A groove runs the full length of the labrum on the anterior surface, widening at the extremity of each segment. This groove is narrower in the fourth than in any of the others. In the cross sections of the beak (Figs,5-10) the fourth seg-

ment almost completely encloses the mandibular and maxillary bristles.

The relationship between the stylets, the labrum, and the labium is shown in the cross sections (Figs.5-7, 9-10). Considering the position of the beak while feeding, the labium is caudad to the rest of the parts and is always the largest (Figs.5-7, 9-10). The labrum (Lm, Figs.5-7,9) is a crescentic structure in all of the cross sections, with the exception of the ones made through the basal portion. Figure 5 shows a section which was taken through this region of the beak. In this section the labrum appears as an elliptical structure fitting tightly around the stylets with a very small groove on the caudal surface.

The mandibular bristles (MdB, Figs.3,5-10) are thinner than the other stylets. In cross sections they are nearly crescentic in appearance, curving to fit the sides of the maxillary bristles (MxB, Figs.3,5-10) which are the interlocking parts located in the middle of the fascicle. The bristles have longitudinal grooves and ridges on their opposing surface, causing them to lock tightly together but allowing each to slide lengthwise without moving the other (Fig.7). The enlarged apices of the mandibular bristles show them to be more irregular and smaller than the apices of the maxillary bristles (Fig.8).

There are two large grooves on the inner surface of each maxilla. When these grooves come together they form two passages. In the head region the anterior tube is the continuation of the mouth channel, and is known as the food canal (fc, Figs.5-7,9,10). The posterior tube begins at the tip of the salivary meatus (sm, Fig.41) and is called the salivary canal (sc, Figs.5-7,9,10). Sometimes the bundle of stylets is twisted so that it is difficult to tell which canal is uppermost (Fig.6). The beak of Corizus lateralis is very similar to that of Anasa tristis DeGeer as described by Tower (1913).

The bases of the stylets are found on each side of the hypopharynx (Hphy, Fig.2). The mandibular bristles originate in the anterior ventral part of the head. Each is divided at the base into two arms, resembling those of the cicada (Snodgrass, 1935). One arm (ra, Figs.2,3) extends posteriorly and laterally toward the upper part of the head where it flattens into a paddle-shaped extremity. There are two retractor muscles attached to this arm. The smaller one ($rmdb_3$, Figs.2, 3) extends posteriorly until it reaches its point of origin on the occiput (Oc, Fig.3).

Turning laterally and dorsally, the anterior arm or lever (lvr, Figs.2,3) of the mandibular bristle proceeds until it touches the mandibular plate (g, Fig.2). At this point a thin apodeme (Ap, Fig.2) connects the bristle with the wall of the

head, probably functioning as a hinge. The anterior arm of the mandibular bristle is termed the "lever" by Ekblom (1928, 1929). It appears as a triangular plate, resembling the one he describes for his Geocorisae, but it differs slightly from his figures. He shows that the lever is almost an equilateral triangle. The lever of Corizus lateralis is an elongate slender triangle with the narrow base acting as the hinge. There are two muscles attached to this lever-like structure. A protractor muscle (pmdb, Figs.2,3) is fastened to the anterior surface and extends forward to the mandibular plate (A). The second retractor muscle of the mandible ($rmdb_2$, Figs.2,3) goes posteriorly to the dorsal arm of the tentorium (DT, Figs.2,3).

The maxillary bristle (MxB, Fig.3) is not as complicated as the mandibular bristle. As in the posterior arm of the mandible (ra, Figs.2,3), the base flattens into a broad area. There are two protractor muscles attached to this base. One (pmxb, Fig.3) goes forward to the inner surface of the maxillary plate (B). The other maxillary protractor muscle ($pmxb_2$, Fig.3) originates on the lateral wall of the hypopharynx (Hphy).

Only one retractor muscle of the maxilla (rmxb, Fig.3) occurs. It begins on the wall of the occiput (Oc) between the attachment of the third retractor muscle of the mandible ($rmdb_3$, Fig.3) and the posterior arm of the tentorium (PT, Fig.3).

Antennae

(Pl.I, Figs.1-4; Pl.III, Fig.12)

In the antenna of Corizus lateralis are six segments. The proximal one begins in the membranous part of the head called the antennal socket. A ridge or antennal suture (as, Figs.4,12) surrounds the socket to form a universal joint with the bulbous base of the first segment or scape (Scp, Fig.12). This segment is thicker than the others and has a stalked base. The second or pedicel (Pdc, Fig.12) and the fourth (4) are long and slender. Numbers three (3) and five (5) are termed ring joints (rj, Fig.12) and, because they are so short, allow great flexibility.

The terminal segment is longer than any other division and is nearly as thick as the scape (6). It is spindle-shaped and has many small sensory setae covering the entire surface. Tactile setae (Set, Fig.12) occur on the other segments but not in such great numbers. They are usually larger in the proximal segments (Fig.12).

Labial Glands

(Pl.I, Fig.3; Pl.III, Figs.11,13; Pl.XIV, Fig.41; Pl.XV, Fig.42; Pl.XVIII, Fig.48; Pl.XIX, Fig.50; Pl.XX, Fig.53; Pl.XXV, Fig.62; Pl.XXVIII, Fig.68; Pl.XXIX, Fig.70; Pl.XXXI, Fig.75)

All of the labial or salivary glands (SlGl, Figs.11, 50, 53,62,68,70,75) are located in the abdomen with the exception of one lobe, which occurs in the metathorax. Constrictions divide the whole structure into a cluster of irregular lobular masses. These are connected with each other to form a unit on each side of the ventriculus. In all of the glands studied, no two had exactly the same shape.

Leaving the middle of the glands at a point between the lobes and the ventriculus, the salivary ducts (SlD, Figs.11,41, 42,61) travel toward the head along the sides of the alimentary canal. There are numerous convolutions present in each duct. After twisting many times in the thorax, the ducts enter the head through the foramen magnum (For, Fig.4), remaining laterad to the nerve cord. In the head the ducts are close to the ventral surface. There are no coils in this region. Coming close together, the ducts unite to form a single tube which immediately empties into the floor of the salivary syringe (Syr, Figs.11, 41,42,48). The salivary ducts are composed of cells which resemble those of the salivary gland in their staining reactions and large size. They are so large that only two cells complete-

ly surround the lumen of the canal (Figs.13,56).

According to Snodgrass (1935), the salivary syringe is present in all Hemiptera. In Corizus lateralis it is located in the hypopharynx and consists of a small hollow cup with the posterior end greatly invaginated (Figs.41,43). An apodeme (Ap, Fig.41) is present in this indentation, leading caudad to connect with the diverging large dilator muscles (dlsyr, Figs. 3,41,42). These two muscles originate in the region of the occiput (Oc, Fig.3) on both sides of the foramen magnum (For, Fig.3).

When the dilator muscles contract, the pistill (P, Fig.41) is retracted. This action resembles that of the plunger in a hypodermic syringe. Salivary secretions are sucked into the cavity and, after a relaxation of the muscles, the elasticity of the walls forces the liquid into the salivary meatus (sm, Fig.41). Small flaps are located at the salivary duct orifice and in the salivary meatus. These probably function as valves to keep the liquid flowing in only one direction. Weber (1930) has given an account of the salivary syringe mechanism in other Hemiptera.

THE THORAX

Prothorax

(Pl.IV, Fig.15,16; Pl.VII, Fig.23)

Resembling Belastomidae (Snodgrass, 1909) and Nezara (Malouf, 1932), Corizus lateralis has no cervical sclerites. The prothorax is evaginated anteriorly, partially enclosing the occiput when the head is retracted. The prothorax has no wings, and is not modified by the division of the tergopleural regions into separate areas, as are those of the mesothorax and metathorax (Figs.15,16,23).

In the prothorax the pleural ridge (PlR, Figs.15,23) is poorly developed. The pleuro-coxal process ($CxPl_1$, Figs.16,23) which contains the pleural suture (PlS_1, Figs.16,23) is in the coxal cavity. Cephalad to this cavity is the episternum (Eps_1, Figs.16,23), while the epimeron (Epm_1, Figs.16,23) is behind and above the coxal cavity.

The sternum and the pleuron (Pl, Figs.16,23) are united. Between the coxal cavities is a sternacostal suture (k, Fig.23). Cephalad to the suture is the basisternum (Bs, Fig.23). Behind the groove is the sternellum (Sl, Fig.23)(Snodgrass, 1929).

The prothoracic tergum (T_1, Figs.15,16) is much larger than that of the mesothorax. A thick longitudinal ridge may be seen in the median portion of the tergum when the dorsal and

ventral surfaces are viewed. Ventrally, the ridge rests in the longitudinal groove of the mesothorax.

A shiny transverse groove in the anterior portion of the prothoracic tergum represents the point where the anterior margin of the mesothorax rests against the under side of the prothorax.

Mesothorax

(Pl.IV, Figs.15,16; Pl.VII, Fig.23)

The mesothorax and the metathorax combine to form the pterothorax which bears the wings (Fig.16). Due to the attachments of the wings, the terga are modified more than the pleura and the sterna.

Viewed from above, the mesothoracic tergum or notum (T_2, Figs.15,16) shows a groove (m, Fig.15) between two parapsides (Par, Fig.15) which unite in the rear of the scutum (Sct_2, Fig. 15).

On both sides of the anterior end of the tergum are prescutal sutures (Pscs, Fig.15) which penetrate almost as far as the parapsides. The narrow portion anterior to this suture is the prescutum ($Prsc_2$, Fig.15). An antecostal suture (acs, Fig. Fig.15) tapers laterally until it disappears in the prescutal region. The scutum (Sct, Fig.15) is separated from the scutellum by a transverse suture (ts, Fig.15).

Vectis dorsualis anterior (vda, Fig.15) and vectis dorsualis posterior (vdp, Fig.15) (Malouf, 1932) are two processes attached to the scutum. They act as wing elevators when the tergosternal muscles (TSt, Figs.40,44,50,53,57,74) contract.

As a triangular flap, the scutellum (Scl_2, Fig.15) extends posteriorly over the middle of the first abdominal segment. The postscutellum ($Pscl_2$, Fig.15) is the area beneath the base of the scutellar prolongation. Uniting with the postscutellum, the mesothoracic epimeron (Epm_2, Fig.15) forms the postalare bridge (Pa, Fig.15). Ventrally, the second thoracic phragma joins the sternal furcae. The phragma is intersegmentally located between the mesothoracic and metathoracic segments.

The pleural ridge (PlR_2, Fig.15) of the mesothorax is continuous with the pleuro-coxal process ($CxPl_2$, Fig.15). The large spisternum (Eps_2, Fig.16) is anterior to the pleural ridge. The smaller epimeron (Epm_2, Figs.15,16) forms the posterior margin of the ridge.

The pleuron is attached to the sternum without a dividing fissure. A basisternal flap is formed between the coxae of the mesothorax. Anterior to this flap is the basisternum (Bs_2, Fig.23).

The posterior margin of the pleuron (Fig.16) is distinctly serrated. This is especially evident when the mesothorax and metathorax are separated.

Metathorax

(Pl.IV, Fig.15,16; Pl.VII, Fig.23)

The tergum (T_3, Figs.15,16) is divided into the scutum (Sct_3, Fig.15) and the scutellum (Scl_3, Fig.15). The postscutellum ($Pscl_3$, Fig.15) unites with the episternum (Eps_3, Fig.15), which is the anterior portion dorsal to the pleurocoxal process ($CxPl_3$, Figs.16,23). The sternacostal suture (k, Fig.23) is posterior to the basisternum (Bs_3, Fig.23), where the ostiole of the scent gland is located.

Surrounding the ostiole is an area with a pebbled surface. This rugose area extends dorsally almost to the tergum and rests against the posterior serrate margin of the mesothorax. The whole region probably serves as the evaporation area of the repugnatory gland secretions.

Legs

(Pl.IV, Fig.16; Pl.V, Figs.17,19; Pl.VII, Fig.23)

The legs (Figs.16,17,19,23) are composed of those segments typical for most insects. Beginning proximally, the divisions (Fig.17) are the coxa (Cx), trochanter (Tr), femur (Fm), tibia (Tb), tarsus (Tar), and pretarsus (Ptar). Numerous setae are present on each of the segments.

An articular corium (ArCor, Fig.17) exists between the segments, allowing the joints to be flexible. The coxa (Cx, Fig.17) is an enlarged globular proximal segment which is allowed to move freely in the coxal cavity or acetabulum by means of the articular corium.

A small segment connects the coxa and the large femur, and is called the trochanter (Tr, Figs.16,17). The basal portion of this small segment is narrowly stalked. The distal region joins obliquely with the side of the femur. Because of the mass of tibial muscles contained therein, the spindle-shaped femur (Fm, Figs.16,17) is the largest part of the leg. A short angle formed at the proximal end of the tibia (Tb, Fig.16,17) permits this segment to be held close to the femur.

There are three tarsomeres (Tar, Figs.17,19) in the tarsus. The proximal segment of the foot is the longest. It is called the basitarsus (Btar, Fig.17). The tarsal segments move very readily due to the thinness of connecting membranes. There are no muscles found in this part of the leg.

The tarsus ends in specially modified structures included in the pretarsus (Ptar, Figs.17,19). Divergent lateral claws (un, Figs.17,19) are articulated dorsally to the unguifer (K, Figs.17,19), which represents the terminal end of the last tarsomere. The unguitractor plate (Utr, Fig.19) is separated into two parts which have transverse ridges. Beneath each claw is located a large flattened pad or pulvillus (Pv, Fig.19),

enabling Corizus lateralis to walk on smooth surfaces.

Wings

(Pl.V, Fig.18; Pl.VI, Figs.20,21)

The fore and hind wings of Corizus lateralis are very different from each other. The front wing is long and paddle-shaped, while the hind one is triangular and is folded along its caudal margin. It is membranous in its entirety.

Large veins covered with setae are found in the proximal portion of the mesothoracic wings. The areas between the veins are nearly as transparent as the apical membranous region. On the insect the two portions look the same, due to their transparency and the appearance of the structures underneath. When the wings are mounted on a slide, however, one can see that the veins in the membranous parts are much less conspicuous. Small sclerotized structures called axillaries (Ax, Fig.20) connect the basal portion to the mesothorax. These are used in the extension and flight movements.

The arrangement of the veins of the mesothoracic wings of Corizus lateralis resembles that found in its relative, Anasa tristis DeGeer, as described by Tower (1913).

Two sutures divide the coriaceous part of the mesothoracic wing into three areas. In front of the median furrow

(mf, Fig.20) is the embolium (e, Fig.20), which is located in the costal area of the wing. The costa, subcosta, and the radius veins are enclosed in this region (Comstock, 1918).

The clavus (cl, Fig.20) is the area behind the claval suture (cls, Fig.20). It contains the cubitus and anal veins.

Between the median furrow and the claval suture lies the corium (co, Fig.20), which occupies the center of the wing. The media traverses this region.

Because of their large size and fuscous appearance, the veins of the coriaceous portion are easily seen. Only the main veins are found in the base of the front wing, probably due to its modification for protection (Hoke, 1926).

In the embolium (Fig.20) costa (C), subcosta (Sc), and radius (R) are united throughout most of their length. The radius diverges near the apex to curve back and fuse with the media (M, Fig.20), which is the prominent vein in the middle of the corium. This vein divides distally to form the first and second media (M_1 and M_2).

The cubitus (Cu, Fig.20) is located posteriorly and adjacent to the claval suture. It is highly sclerotized until it reaches the membrane.

The anal or vannal vein (V, Fig.20) is the last one in the hind portion of the wing. Proximally, the vein is large, but tapers gradually until it disappears.

In the membranous area the veins are very irregular. Their mode of branching and uniting was not constant in the various individuals which were examined.

The hind wing has numerous veins and folds. These divide the wing into three main regions. Using the terminology of Snodgrass (1935) the remigium (Rm, Fig.21) is the largest and outermost area. It is limited posteriorly by the vannal fold (vf, Fig.21). The costal, subcostal, radial, medial, cubital, and postcubital veins are contained in the remigium.

Located between the postcubitus (Pcu, Fig.21) and the first vannal vein (1V, Fig.21) is the vannal fold (vf, Fig.21). Behind this fold is an area called the vannus (Vn, Fig.21). Included in this region are the two vannal veins (1V,2V, Fig.21).

Behind the vannus, and always folded beneath it when at rest, is a small area called the jugum (Ju, Fig.21). It is separated from the vannus by means of the jugal fold (jf, Fig. 21).

The costa (C, Fig.21) or costa primaria (Fieber, 1861) and subcosta (Sc, Fig.21) are fused proximally in the costal region at the base of the wing. These veins remain together about half the length of the wing. At this point the subcosta branches off and unites with the radius (R, Fig.21) for a short distance before reaching the apex of the wing.

Arising close to the humeral plate (HP, Fig.21), the radius (R, Fig.21) extends toward the apex of the wing before it

bends to unite with the media (M, Fig.21) for a short distance. Leaving this vein, the radius turns toward the costal margin. This connecting portion of the radius was termed costa connectens by Fieber (1861). It joins with the subcosta to form an angle; then travels alone to the margin of the wing.

Three branches of the media or costa decurrens are present. As described above, the first (M_1, Fig.21) unites with the radius for a short distance near its middle portion. The second (M_2, Fig.21) does not begin in the base of the wing. It appears as a thin vein in the space between the first media and the third branch (M_{3-4}, Fig.21). M_1 and M_2 unite just before disappearing at the edge of the remigium. The third branch (M_{3-4}) is a large straight vein which extends without branching from the axillary plate (AxP, Fig.21) to the margin.

The cubitus or costae lineatae (Cu, Fig.21) resembles M_{3-4} in that it is primitively two-branched. In Corizus lateralis there is only one vein.

Between the vannal fold (vf) and the jugal fold (jf) are two short vannal veins (1V,2V). These begin proximally as very thick veins, but they taper sharply and do not reach the margin of the vannus.

There is only one jugal vein (J, Fig.21) in the jugum (Ju). It is so short and slender that it would be easily overlooked unless special precautions were taken to unfold the jugum, thus preventing the first vannal from obscuring so small

a vein. The vannal and jugal veins were called the costae radiantes by the earlier workers (Fieber, 1861).

When the wings are in the flying position the claval margin of the fore wing overlaps the costal margin of the metathoracic wing, allowing the two to function as one unit (Fig. 18). This type of coupling device has been described for other Hemiptera (Weber, 1930, and Malouf, 1932).

THE ABDOMEN

(Pl.IV, Figs.15,16; Pl.VII, Figs.22,23; Pl.XIII, Fig.36; Pl.XXVI, Fig.63; Pl.XXX, Fig.73)

The abdomen is slightly larger than the thorax to which it is broadly attached (Fig.23). Ventrally, it is difficult to see the first abdominal segment because the posterior portion of the metathorax encloses it. Two spiracles (Sp, Figs.16,23) are located in the lateral portion of the sternum, in each of the first seven segments. Dissections or bleaching and clearing of the specimens is necessary in order to see the first and seventh pairs. A small atrium (Atr, Fig.73) is present in each of the spiracles.

Malouf (1933) considers the first abdominal segment to be a part of the pterothorax. In Corizus lateralis this segment is united with the metathorax to form an immovable union. Only a portion of the sternum and the tergum may be seen (Figs.15, 16).

The margins of the fourth abdominal tergum are concave at the base and the apex. This is correlated with the presence of the dorsal scent gland and the apodeme (Figs.22,32).

A prominent ridge or connexivum (Con, Figs.15,22) occurs on each side of the abdomen, producing a trough-like appearance. Between these ridges on the dorsal side is a flattened area called the tergum (T, Figs.15,22), which is covered by

the resting wings.

The dorsal portion of the abdomen is covered with numerous pits, each containing a seta. These may be seen in the longitudinal section in Figure 65. Many pits are found in various parts of the body, especially in the thorax.

There are six abdominal segments generally exposed in Corizus lateralis. In the female the dorsal portion of the sixth segment is triangular with the apex ending in a rounded point. This segment of the male is longer than that of the female and has a slight constriction in each lateral margin. Blatchley (1926) has very capably described the abdominal segments.

The eighth segment is so small it is hard to detect. It is found at the base of the ninth, which bears the periphallic structures (Snodgrass, 1935) in both male and female. The ninth is the largest of the posterior segments. The tenth segment or cauda (Weber, 1933) surrounds the anus (Singh-Pruthi, 1925). Ekblom (1928) gives a description of the ninth without mentioning the tenth. Newell (1918) mentions that an eleventh segment sometimes occurs in Hemiptera.

The appendages of these segments are described in the discussion of the male and female genitalia.

THE ALIMENTARY CANAL

(Pl.VIII, Fig.25; Pls.XIV-XVIII, Figs.40-48; Pl.XIX, Fig.50; Pl.XX, Fig.51; Pls.XXI,XXII, Figs.55-57; Pls.XXIII,XXIV, Figs.59-61; Pls.XXVI-XXIX, Figs.65-71; Pl.XXXI, Fig.75)

The alimentary canal is composed of three main parts, the stomodaeum (Stom, Fig.25), mesenteron (Ment, Fig.25), and proctodaeum (Proc, Fig.25). Each of these has subdivisions of morphological importance.

The stomodaeum is divided into the pharynx (Phy, Figs.25, 42,47,48), oesophagus (Oe, Figs.25,40,45,54), crop (Cr, Figs. 25,40,42,43,50,51,56,61,68,75), and proventriculus (Pvent, Figs.25,68).

Large dorsal dilator muscles of the pharynx (dlphy, Figs. 40-44,46,48) originate in the frontal and dorsal areas. The muscles are the largest of any in the head. The intima is very thick and brown in this region of the stomodaeum. Muscle fibers appear to penetrate the pharynx almost as far as the intima (Fig.41).

Between the median dorsal muscles (mD, Figs.42,43,50,52, 55,59,60,62,74), connecting the pharynx and the crop, is an extremely slender tube, — the oesophagus. It expands gradually into the anterior portion of the crop. Many longitudinal folds composed of crop cells (CrCls, Fig.55) allow for food distension.

Food is stored in the crop until the ventriculus can receive more for digestion. Authorities cannot agree whether the digestion which occurs in this region of the digestive tract is due entirely to the enzymes from the salivary glands and regurgitations from the ventriculus or whether the crop walls have a secretion (Abbott, 1926 and Wigglesworth, 1928).

In Corizus lateralis the proventriculus is the portion marked off by a very small constriction at the posterior end of the stomodaeum. Internally, the constriction is the cardiac or stomodaeal valve (SVlv, Figs.40,43,50,56), which protrudes into the anterior part of the ventriculus.

The mesenteron of the alimentary canal contains the ventriculus. It extends from the stomodaeal valve to the region just anterior to the point of union of the Malpighian tubules (Mal, Figs.25,68) with the proctodaeum.

There are two easily recognized divisions of the ventriculus. When a fresh specimen is dissected, the first part (lVent, Fig.25) appears as a dilated white sac which is usually so filled with gases that it seems to be moored by means of the slender tracheae on each side. When the digestive tract is removed from the rest of the viscera, the inflated portion actually floats the whole structure to the surface of the saline solution used in the dissections. Sections show that this first part has extremely large digestive cells (Vent, Fig. 70).

The second part (2Vent, Fig.25) of the ventriculus is a long tube which is usually coiled twice into a spiral. When uncoiled, the tube is twice the length of the first part of the ventriculus.

Connected with the posterior part of the mesenteron is the proctodaeum (Proc, Fig.25), which is also divided into two regions, the anterior intestine (AInt, Fig.25) and the posterior intestine (PInt, Fig.25). The anterior intestine is separated from the mesenteron by means of a pyloric valve (PVlv, Fig.25).

There are four Malpighian tubules (Mal, Fig.25) entering this region. Two unite at their bases on each side of the alimentary canal and resemble only two tubules attached to the intestines. After coiling and winding around each other, these excretory structures end blindly and separately in the body cavity. In some Hemiptera (Snodgrass, 1935) the Malpighian tubules are said to unite at their free ends.

The posterior intestine (PInt, Fig.25) is only slightly bulbous at its anterior end, tapering gradually until it forms a straight tubular rectum (Rect, Figs.25,65). This tube opens exteriorly through the anus (an, Figs.25,31,32,65). Rectal papillae are not present in Corizus lateralis.

THE HEART

(Pl.VIII, Fig.24; Pl.XXIII, Fig.59; Pl.XXIX, Fig.71)

In Corizus lateralis the heart (Ht, Figs.24,59,71) is a simple tubular vessel. It is held in close contact with the body wall of the dorsum by means of the muscles of the dorsal diaphragm (DDph, Fig.71) and possibly by the pressure of the engorged ventriculus. The diaphragm is a delicate membrane which is attached at the lateral margins of the dorsum. The ventriculus frequently forces the heart against the body wall, due to the distension produced by food or gases. When the ventriculus is not inflated the heart sags slightly.

Three pairs of ostia (Ost, Fig.24) divide the heart into three chambers which are located in the abdominal region. The chambers are not very pronounced, being only slightly widened portions of the blood vessel. Posteriorly, the heart ends abruptly just behind the third cardiac chamber in the sixth segment.

The ostia are extremely difficult to see. They appear as tiny vertical elliptical perforations when viewed laterally in dissections of living specimens. Regular pulsations of the heart cause these openings to enlarge slightly. When powdered carmine is placed in the solution surrounding the heart the tiny particles can be seen as they are sucked through the ostia and pumped forward toward the brain.

Pericardial cells (Pcls, Figs.59,60) are numerous around

the heart. These structures are probably the nephrocytes which Hollande (1922) described as being important from an excretory standpoint. When the heart is removed in toto adjacent cells adhere to it, making the whole unit appear as a long sac of adipose tissue. When observed in stained sections, however, the cardiac cells may be distinguished from the nephrocytes by means of the binucleate condition and the acid staining reaction of the latter.

That portion of the dorsal blood vessel which extends into the thorax and the head is called the aorta (Ao, Figs.24,52,54, 60,75). It is slightly smaller than the heart and has no ostia or separate chambers. No pulsations are seen in this region. The aorta terminates at a point ventral to the brain. There is an average of eighty-five contractions of the dorsal vessel per minute. When the heart is surrounded by a warmer solution as many as one hundred ten beats per minute may be seen. The pulsations begin at the posterior end and, with a peristaltic action advance forward into the aorta. Many hearts were observed but at no time was there seen a reversal of the movements as in some insects (Gerould, 1929). The pulsations continue for a short time after the heart is removed from the dorsal diaphragm.

THE NERVOUS SYSTEM

(Pl.IX, Figs.26-28; Pl.XIV, Fig.40; Pl.XV,XVI, Figs.42-45)

In dissections of freshly killed specimens the nervous tissues appear white or cream colored. The fibers are minute and delicate and it is extremely difficult to expose them by dissecting away the overlying structures.

Most of the illustrations are reproduced from a compilation of drawings of serial sections which are forty micra thick. It is easier to trace the nerve fibers in these sections than in the thinner ones. Minute details of the nerves and ganglia may be studied in the thinner sections.

When the serial sections are stained with Delafield's Hematoxylin and counter-stained with eosine the nervous tissue is easily distinguished from the other structures because its cells are a darker bluish-purple. The branching of the fibers also help in locating the nerves.

A great portion of the head is occupied by the brain (Br, Figs.26,28,40,42,43). It is located in the posterior portion with the large optic nerves extending anteriorly and laterally.

The brain is divided into the fore brain or protocerebrum (1Br, Fig.27), the mid brain or deutocerebrum (2Br, Fig.27), and the hind brain or tritocerebrum (3Br, Fig.27). These three lobes are not sharply delimited from each other as in the case

of some insects.

The brain's largest appendages are the optic lobe (Opl, Figs.26,27), the ocellar pedicels (OPdcls, Fig.27), the antennal nerves (AntNv, Figs.26-28), and the circumoesophogeal connectives (CoeCon, Fig.27). The optic lobes are nearly as large as the brain itself. Connecting the lobes with the protocerebrum is a short thick optic nerve. Because of the great diameter of this nerve, it appears as if the lobes are a part of the main brain.

The prominent ocellar pedicels originate from the protocerebrum and terminate in the corneagenous cells (CgCls, Fig. 51) which are beneath the cornea (Cor) of the ocellus (O, Fig. 27).

The motor and sensory nerve fibers are combined in one nerve up to the base of the antennae. At this point the motor nerves branch off into the antennal muscles, while the sensory nerve proceeds into the middle of the antennae.

Because of their small size, the other nerves leading out of the brain are difficult to trace. The labrofrontal nerves originate from the tritocerebrum and extend anteriorly. They then divide into the labral nerve (LmNv, Fig.27) and the frontal ganglion connective (Fr, Con, Fig.27). The former proceeds ventrally to the labrum, while the latter unites with the one of the opposite side to form the frontal ganglion (FrGng, Figs.26-28). A very small recurrent nerve (RNv, Fig.27) extends pos-

teriorly from this point where it disappears beneath the brain.

Short circumoesophageal connectives (CoeCon, Fig.27) link the brain with the ventral nerve cord. These circle the oesophagus, connecting the tritocerebral lobes and the suboesophageal ganglion. Snodgrass (1935) includes the tritocerebral lobes with the ventral nerve cord.

The suboesophageal ganglion (SoeGng, Figs.26-28,43,44) lies beneath the oesophagus, at a point slightly behind and below the brain. It innervates the mouth parts, salivary ducts, and the muscles located in the neck.

The mandibular nerve (MdNv, Fig.27) extends cephalad to the muscles of the mandibles. The maxillary nerves (MxNv, Fig. 27) are slightly larger and are attached to the muscles of the maxillae. Both the labial nerves (LbNv, Fig.27) and the hypopharyngeal nerves (HphyNv, Fig.27) extend laterally and ventrally and penetrate into the labium and hypopharynx, respectively.

A single ganglion (Gng_1, Figs.26,28,42-45) occurs in the prothorax. The three pairs of main lateral nerves (1Nv,2Nv, 3Nv, Figs.28,45) radiate from this nerve center. Running cephalad, the first lateral nerve penetrates the muscles in the anterior region of the prothorax. These muscles are also innervated by the second lateral nerve. The third lateral nerve is the largest of the three. It proceeds laterally, to disappear into the base of the prothoracic leg.

As in Nezara (Malouf, 1933), there are no abdominal ganglia in Corizus lateralis. The ganglia of the abdomen are fused with those of the mesothorax and metathorax to form a large pterothoracic ganglion (Gng_{2-3}, Figs.26,28,42,44). Because of a distinct transverse constriction, this ganglion appears in the frontal serial sections as two parts (Fig.44). Numerous branches from a large median nerve (MedNv, Fig.26,28) terminate in the last six segments of the abdomen. The anterior abdominal segments are innervated by nerves leading directly from the pterothoracic ganglion (Fig.26).

The thoracic ganglia are connected with each other by means of short thick interganglionic connections (con, Fig.28). Between the bases of these connectives is a median nerve (MedNv, Fig.28) which extends posteriorly from each ganglion. No lateral branches of this nerve were found.

THE ORGANS OF REPRODUCTION

Female Genitalia

(Pl.X, Fig.30; Pl.XI, Fig.32; Pls.XXIV-XXVII, Figs.61-67)

The genitalia are normally retracted into the sixth segment. Examination of the insect from a ventrocaudal view (Fig.32) occasionally affords an observation of the tips of segment seven and nine and a portion of the anal lip (an, Fig. 32). After the sternal portion of the sixth segment is removed, the inner features may be seen without difficulty.

The ventral area of the seventh segment is very soft and membranous. In the ventro-lateral portions are found the first valvifers (1Vlf, Fig.32), which are attached to the eighth segment. They are short thick hooks which are flattened and directed posteriorly and then dorsally. The apex of each is covered with numerous setae.

The eighth segment is greatly reduced and retracted. Small pad-like projections which articulate with the larger ninth segment are known as the second valvifers (2Vlf, Figs.32,65). They are dorsal and lateral to the first valvifers.

Tiny spindle-shaped ovarioles (Ovl, Fig.30) compose the ovaries (Ov, Figs.30,61-63). Anteriorly, the ovarioles taper into slender terminal filaments (TF, Figs.30,63) which unite

into a thread-like bundle. It ends in the adipose tissue of the thorax (Fig.63). When the surrounding organs are removed, the filaments still support the ovaries in their normal position.

Small pedicels (Pdcl, Fig.30) representing ovariole ducts unite with each other to form a common lateral oviduct (Odl, Fig.30). They curve mesally and combine to produce the oviductus communis (Odc, Fig.30). This common oviduct is short and wide. It enters the genital chamber or vagina (GC, Figs. 30,67). The accessory gland (AcGl, Figs.30,63-65) is located on the floor of the sternum, in the sixth abdominal segment. There is a small duct leading from it into the genital chamber.

As in Nezara viridula L. (Malouf, 1933), the spermatheca (Spt, Figs.30,32,66,67) is modified into a complicated structure. It is sac-like, with one diverticulum of its duct coiled around the narrow portion of the sac. Large cells completely surround the spermatheca, located between the sixth and the seventh abdominal segments. The spermatheca and the duct are provided with many muscles, which are probably used to pump the sperm cells out to the eggs when fertilization occurs.

Male Genitalia

(Pl.X, Fig.29; Pl.XI, Fig.31; Pl.XXVIII,XXIX, Figs.68-71)

The male genital segments normally are enclosed by the sixth abdominal segment. At times, however, the apical portion of the ninth segment and the copulation hooks (coph, Figs. 29,69) may be seen from a ventral view. Snodgrass (1935) refers to these hooks as harpagones, while most taxonomists speak of them as parameres or claspers (Newell, 1918, Singh-Pruthi, 1925). These structures are borne by the ninth segment. The eighth segment is reduced in size and is attached to the base of the ninth or genital segment (Snodgrass, 1935).

A sac-like membranous structure called the phallosoma contains the penis (ps, Figs.29,31,69) or phallus, which is a long tube coiled in a spiral. The ductus ejaculatorius (de, Figs.29,31) is connected with the penis and extends throughout its full length. An ejaculatory reservoir (bl, Figs.29,31) is located in the duct near the penis.

The testes (Tes, Figs.29,68,71) are located in the anterior portion of the abdomen, on both sides of the ventriculus. Each is composed of a group of seven sperm tubes in which the development of the spermatozoa occurs. Around every sperm tube there is an epithelial sheath (ESh, Fig.70). Enveloping the whole testis is a peritoneal sheath (PSh, Fig.70) which is

impregnated with red pigment granules, giving the testis a bright scarlet appearance. In the dissection of a male this color is easily seen with the naked eye, because it is the brightest spot in the entire fresh viscera.

Structures in the longitudinal sections of the testis are readily visible (Fig.70); next to this is the zone of growth (I, Fig.70). The maturation zone (II, Fig.70) and the zone of transformation (III, Fig.70) are the last two areas. "The entire process of spermatogenesis thus takes place regularly within the tubes of the testis." (Snodgrass, 1935).

Leading from the testis to the ejaculatory reservoir are the vasa deferentia (Vd, Figs.29,69), which combine before emptying into the dorsal wall of the reservoir. They are of the same bright red color as the testes. After the tubes unite the color disappears.

THE REPUGNATORY GLAND

(Pl.IV, Fig.16; Pl.VII, Fig.23; Pl.XII, Figs.33-35; Pl.XIII, Figs.36-39; Pl.XXXI, Fig.75; Pl.XXXII, Fig.76)

Some authorities have had the idea that members of the family Corizidae possessed a poorly developed scent gland or lacked it entirely. In fact, Gibson (1919) wrote that Corizus could be distinguished from Nysius by the lack of a prominent osteolar canal and by the simplified odoriferous orifice.

When collections were first made it was difficult to believe that the repugnatory gland was lacking. Invariably, fumes emitted by the insects were drawn into the mouth when a modified "aspirator" or vacuum collecting bottle was used. To the collector, the odor and taste were so strong as to be nauseating. Even before Corizus lateralis was seen in the collecting net, a characteristic scent usually indicated its presence.

The appearance of an ostiole (os, Figs.16,23,37) and its peritreme also indicated the presence of a functioning scent gland. The orifice is located in the metathorax cephalad to the third coxa, between the epimeron and the episternum.

The surrounding peritreme (osperi, Fig.37) is extremely granular and is lighter in color than the adjacent body wall. Presumably, the rugose surface functions as an evaporating plate by increasing the surface area. This area extends

dorsally as far as the limits of the pleurae.

The scent apparatus of Corizus lateralis resembles that of Salda littoralis (Acanthiidae) as described by Brindley (1930) and is somewhat similar to the one of Anasa tristis DeGeer (Moody, 1930).

The gland rests against the sternal body wall between the sternal furca (Fu, Figs.34,35), with a reservoir almost covering the two convoluted tubules. The entire unit is situated in a slight evagination of the sternum, between the bases of the last two pairs of legs. A cushion of adipose tissue (Ft, Fig.33) covers all parts, separating them from the alimentary canal.

The repugnatory or scent glands (Sgl, Figs.33,34,37,38, 75,76) enter the reservoir (Res, Figs.31,33,35,36,73,74) on the ventral surface. Cells forming the tubular wall are slightly larger than those of the salivary duct. A cross section generally shows six or eight cells around the lumen.

Granules in the lumen are the subject of much controversy among various morphologists. Brindley (1930) claims they are endothelial lining cells which are a continuation of the intima of the reservoir. Moody (1930) believes they are secretory granules. Brindley is probably correct in her assumption because the nuclei and nucleoli may be seen in clearly stained sections.

The reservoir is lined with a chitinous intima (Cin, Figs. 33,37), which is continuous with that of the reservoir duct and vestibule. A large number of minute transverse folds make up the intima. These allow for considerable expansion when the container is distended with secretion. This intima resembles that of Macrocorixa geoffroyi, Leach (Brindley, 1929).

Leading through the valve (v, Fig.37), a narrow duct (dres, Fig.37) connects the lateral portion of the reservoir with the vestibule (ves, Fig.37). The lining of the duct is continuous with the chitinous intima of the reservoir. Forming a straight passage, the vestibule opens to the exterior through the ostiole (os, Fig.37). The vestibule lining is continuous with the surface of the ostiolar peritreme (osperi, Fig.37) and shows the characteristic pebbled surface which is present on the evaporating area.

Ejection of the fluid is probably brought about by a contraction of the thoracic muscles, compressing the reservoir and forcing the secretion out into the vestibule. There are no muscles attached to the reservoir or to the glands. A small valvular retractor muscle (Vms, Fig.37) is fastened to the dorsal wall of the valvular mechanism. Contraction of this muscle presumably opens the reservoir duct, allowing the fluid to escape. Very probably the elasticity of the sclerotized wall of the duct keeps the structure closed until the muscle

functions. In sections through the valve the duct is usually completely closed.

Tracheae are found in great abundance among the coils of the scent glands. A few extend upwards on the reservoir but do not penetrate to the intima. There is a tracheal branch which supplies the retractor muscle of the valve.

A dorsal scent gland (Dgl, Figs.22,36,39) (Künckel, 1866) is found in the dorsum of the abdomen of adult Corizus lateralis. This structure has the same reddish orange appearance as that of the metasternal reservoir. It is suspended from the body wall and has a transversely flattened, shrivelled aspect.

An ostiole (os, Figs.22,34) in the anterior median portion of the fourth abdominal segment supplies an external opening for the dorsal repugnatory gland. This orifice is a transverse slit-like opening situated in a small protuberance of the dorsum. Internally, a dilator muscle (dlm, Fig.36) is attached to a tiny apodeme in the posterior part of the same segment.

Laterally, the gland is supplied with a number of small tracheoles (tr, Fig.39) which branch from a large trachea on each side of the body.

The dorsal scent gland is not connected with the metathoracic gland. No discharge of secretion from the dorsal orifice was observed.

SUMMARY

Corizus lateralis is a small Hemipteron which occurs in many localities in the United States. More of these insects were found on smart weed than on any other host plant. It hibernates as an adult in clumps of grass, leaves, and other debris.

Dissections were made after the insects were hardened by boiling for fifteen minutes. Serial sections forty micra thick proved better than thinner ones for studying the gross anatomy. A new method was found to facilitate observations of nearly transparent wing veins.

A simplified microprojector was assembled to aid in drawing. This proved to be more satisfactory than a camera lucida. Photomicrographs were made by projecting the image onto photographic bromide enlarging paper, instead of using a negative.

The head of Corizus lateralis is typical of most Hemiptera, the sclerites being fused into a hard capsule. From this the four segmented beak extends to a point between the mesothoracic and metathoracic coxae. Each mandibular bristle divides into two arms in the ventral part of the head, while the maxillary bristles do not have branches. Protractor and retractor muscles of the stylets are well developed.

Of the six antennal segments, numbers three and five are

small ring joints.

In the anterior part of the abdomen, the two labial glands have salivary ducts extending anteriorly to the salivary syringe. This syringe has a pistill and two valve-like flaps for ejecting salivary secretions.

There are no cervical sclerites. Pleuron and sternum are fused in the prothorax. The mesothoracic and metathoracic sclerites are modified because of the legs and wings.

The fore wings are partly membranous, partly coriaceous. The veins are described and named. Only the jugal fold is functional in the membranous hind wing. A coupling device for uniting the wings is present.

Six abdominal segments show exteriorly. The seventh, eighth, and ninth are specialized for reproductive and excretory uses.

The alimentary canal is composed of the pharynx, oesophagus, ventriculus, anterior intestine, and posterior intestine.

No rectal papillae or gastric caecae are present. Four Malpighian tubules coalesce at their bases to resemble only two tubules. The tubules end blindly and separately in the body cavity.

There are three pairs of ostia in the heart, located in the abdomen.

The nervous system is composed of the brain, suboesoph-

ageal ganglion, three thoracic ganglia, connectives, commissures, and nerve fibers. There are no abdominal ganglia.

The female has two pairs of valvifers attached to the eighth and ninth abdominal segments. An accessory gland and a spermatheca are located in segments six and seven. In the male there are seven sperm tubes in each testis. In both sexes the testes and ovaries are in the anterior part of the abdomen.

The well developed repugnatory gland is found in the evagination of the sternum between the last two pairs of legs. Above the gland is a thin walled reservoir which is usually filled with secretion. In the fourth abdominal segment there is a small dorsal scent gland.

LITERATURE CITED

Abbott, Roy L.
1926. Contributions to the physiology of digestion in Australian roach, Periplaneta australasiae Fab. Jour. Exp. Zool., 44(1):219-253, 2 pl.

Becker, E. R. and Roudabush, R. L.
1935. Brief directions in histological technique. Collegiate press, inc., Ames, Ia., 80 p.

Blatchley, W. A.
1926. Heteroptera or true bugs of eastern North America with special reference to the faunas of Indiana and Florida. Nature Publ. Co., Indianapolis. 1116 p. 12 pl. 215 figs.

Brindley, Maud D.Haviland
1929. On the repugnatorial glands of corixa. Trans. Ent. Soc. London, 77(1):7-13. 5 figs.

Brindley, Maud D. Haviland
1930. On the metasternal scent-glands of certain Heteroptera. Trans. Ent. Soc. London, 78(2):199-207. 1 pl. 4 figs.

Comstock, J. H.
1918. The wings of insects. Comstock Co., New York. XVIII + 430 p. 10 pls. 427 illustr.

Distant, W. L.
1880-1893. Biologia Centrali-Americana. Insecta. Rhynchota. Hemiptera - Heteroptera. I:XX-462 pp. 39 pls.

Ekblom, Tore
1928. Morphological and biological studies of the Swedish families of Hemiptera - Heteroptera. II. The families Mesoveliidae, Corizidae and Corixidae. Zool. Bidrag fran Uppsala, 12:113-150. 109 figs.

Ekblom, Tore
1929. New contributions to the systematic classification of Hemiptera - Heteroptera. Ent. Tidskr., 50:169-180. 16 figs.

Fieber, F. X.
1861. Die europäischen Hemiptera; Halbflügler. (Rhynchota Heteroptera.) Carl Gerold's Sohn. Wien. pp. 444. 2 pls.

Gerould, J. H.
1929. Periodic reversal of the heart action in the silk-worm moth and pupa. Jour. Morph., 48:385-429. 1 pl. 4 figs.

Gibson, E. H.
1919. Notes on the North American species of Corizus (Coreidae, Heteroptera). Canad. Entom., 51:89-92.

Hambleton, J. C.
1908. The genus Corizus. With a review of the North and Middle American species. Ann. Ent. Soc. Amer., 1:133-152. pl.

Hambleton, J. C.
1909. Life History of Corizus lateralis Say. Ann. Ent. Soc. Amer., II:272-276. pl.XXIX.

Hoke, Sara
1926. Preliminary paper on the wing-venation of the Hemiptera (Heteroptera). Ann. Ent. Soc. Amer., 19(1): 13-34.

Hollande, A. C.
1921. La cellule péricardiale des Insectes (cytologie, histo-chimie, rôle physiologique). Arch. Anat. microsc. 18:85-307. 4 pls. 31 figs.

Künckel, M. J.
1866. Recherches sur les organes de sécrétion chez les Insectes de l'order des Hémiptères. Compt. Rend. Acad. d. Sc., 63:433-436.

Malouf, N. S. R.
1932. The skeletal motor mechanism of the thorax of the "stink bug", Nezara viridula L. Bull. Soc. Roy. Ent. Égypte, 16(4):161-203.

Malouf, N. S. R.
1933. Studies on the internal anatomy of the "stink bug", Nezara viridula L. Bull. Soc. Roy. Ent. Égypte, 17: 96-119. 7 pl. 1 fig.

Moody, D. L.
1930. The morphology of the repugnatory glands of Anasa tristis DeGeer. Ann. Ent. Soc. Amer., 23:81-104. 5 pls.

Newell, A. G.
1918. The comparative morphology of the genitalia of insects. Ann. Ent. Soc. Amer., 11:109-142. pls.IV-XVII.

Readio, P. A.
1928. Studies on the biology of the genus Corizus (Coreidae, Hemiptera). Ann. Ent. Soc. Amer., 21(2):189-199. 2 pls.

Singh-Pruthi, H.
1925. The morphology of the male genitalia in Rhynchota. Trans. Ent. Soc. London, 1925:127-267.

Snodgrass, R. E.
1909. The thorax of insects and the articulation of the wings. Washington, D. C. Smithsonian Inst. U. S. Nation. Mus. Proc. 36 No.1687:511-595. pls.XL-LXIX.

Snodgrass, R. E.
1921. The mouth parts of the cicada. Proc. Ent. Soc. Washington, 23:1-15. 2 pls.

Snodgrass, R. E.
1928. Morphology and evolution of the insect head and its appendages. Smithsonian Misc. Coll., 81(3):1-158. 57 figs.

Snodgrass, R. E.
1929. The thoracic mechanism of a grasshopper and its antecedents. Smithsonian Misc. Coll., 82(2):1-111. 54 figs.

Snodgrass, R. E.
1932. Evolution of the insect head and the organs of feeding. Smithsonian Rept., Washington, D.C., 1931:443-489. 25 figs.

Snodgrass, R. E.
1935. Principles of insect morphology. McGraw-Hill Book Co., New York. IX+667 pp. 319 figs.

Tower, D. G.
1913. The external anatomy of the squash bug, Anasa tristis DeGeer. Ann. Ent. Soc. Amer., 6(4):427-437. pls. LV-LVIII.

Weber, Hermann
1930. Biologie der Hemipteren. Eine Naturgeschichte der Schnabelkerfe. (Vol.11 of "Biologische Studienbücher".) J. Springer, Berlin. VII+543 pp. 329 figs.

Weber, Hermann
1933. Lehrbuch der Entomologie. Fischer, Jena. XII+726 pp. 555 figs.

Wigglesworth, V. B.
1928. Digestion in the cockroach. III. The digestion of proteins and fats. Biochem. Jour., 22(1):150-161.

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EXPLANATION OF PLATES

Pl.I.

Fig.1. Dorsal view of the head.

Fig.2. Internal dorsal view of left side of head, showing muscles of branches of the mandibular seta.

Fig.3. Internal dorsal view of the entire head, showing muscles which operate the bristles.

Fig.4. Ventral view of the head.

Pl.II.

Fig.5. Cross section of beak in region of the salivary syringe.

Fig.6. Cross section through beak in the caudal region of the salivary syringe.

Fig.7. Cross section of stylets, greatly enlarged.

Fig.8. Apices of stylets, greatly enlarged.

Fig.9. Cross section of beak in the region of the prothorax.

Fig.10. Cross section through beak in the mesothoracic region.

Pl.III.

Fig.11. Dissection showing labial glands, ducts, and salivary syringe.

Fig.12. Antenna.

Fig.13. Optical section of portion of salivary duct.

Fig.14. Terminal segment of labium.

Pl.IV.

Fig.15. Dorsal view of thorax and first abdominal segment.

Fig.16. Lateral view of entire body, showing external features.

Pl.V.	Fig.17.	Entire leg.
	Fig.18.	Diagrammatical cross section showing coupling of fore and hind wings.
	Fig.19.	Terminal structures of tarsus, greatly enlarged.
Pl.VI.	Fig.20.	Mesothoracic wing.
	Fig.21.	Metathoracic wing.
Pl.VII.	Fig.22.	Dorsal view of male abdomen.
	Fig.23.	Ventral view of entire body.
Pl.VIII.	Fig.24.	Dorsal view of dorsal blood vessel.
	Fig.25.	Dorsal view of alimentary canal.
Pl.IX.	Fig.26.	Lateral view of nervous system.
	Fig.27.	Anterior view of nervous system.
	Fig.28.	Dorsal view of nervous system.
Pl.X.	Fig.29.	Dorsal view of abdomen, showing male reproductive system.
	Fig.30.	Dorsal view of abdomen, showing female reproductive system.
Pl.XI.	Fig.31.	Sagittal view of the terminal abdominal segments, showing reproductive organs.
	Fig.32.	Optical section of terminal abdominal segments, showing male reproductive organs.

Pl.XII. Fig.33. Median sagittal section through region containing the metathoracic repugnatory gland.

Fig.34. Dorsal view of the metathoracic repugnatory gland.

Fig.35. Dorsal view of the reservoir of the metathoracic repugnatory gland.

Pl.XIII. Fig.36. Median sagittal section through the fourth abdominal tergum, showing the dorsal repugnatory gland.

Fig.37. Transverse section of metathoracic repugnatory gland, showing its valvular mechanism.

Fig.38. Frontal section through ventral portion of the union of thorax and abdomen, showing the location of the metathoracic repugnatory gland.

Fig.39. Ventral view of the dorsal repugnatory gland.

Pl.XIV. Fig.40. Frontal section through head and thorax.

Fig.41. Enlarged sagittal longitudinal section of pharynx and salivary syringe.

Pl.XV. Fig.42. Median sagittal section of head and part of thorax.

Fig.43. Lateral sagittal section of head and part of thorax.

Pl.XVI. Fig.44. Frontal section through ventral portion of head and thorax.

Fig.45. Cross section through oesophagus and first thoracic ganglion. Enlarged.

Pl.XVII. Fig.46. Cross section of head through compound eyes.

Fig.47. Cross section through head, anterior to the compound eyes. Enlarged.

Pl.XVIII. Fig.48. Cross section of head through ocelli.

Fig.49. Whole mount of portion of head showing compound eye and base of antennae.

Pl.XIX. Fig.50. Frontal section of thorax.

Fig.51. Sagittal section through portion of head showing ocellus. Enlarged.

Pl.XX. Fig.52. Cross section through mesothorax.

Fig.53. Frontal section through thorax and anterior portion of abdomen. Made in dorsal region.

Pl.XXI. Fig.54. Cross section through mesothorax in the region of the mesothoracic legs.

Fig.55. Frontal section through crop. Enlarged, with one fold showing.

Pl.XXII. Fig.56. Frontal section through stomodaeal valve.

Fig.57. Frontal section through ventriculus, showing regenerative cells. Enlarged.

Pl.XXIII. Fig.58. Coxa showing muscles. Enlarged.

Fig.59. Longitudinal section in dorsal region of the abdomen, showing the heart.

Pl.XXIV.	Fig.60.	Cross section through dorsal portion of thorax. Enlarged.
	Fig.61.	Frontal section through junction of thorax and abdomen.
Pl.XXV.	Fig.62.	Lateral sagittal section through junction of thorax and abdomen.
	Fig.63.	Frontal section of abdomen.
Pl.XXVI.	Fig.64.	Frontal section of accessory gland of female. Enlarged.
	Fig.65.	Median sagittal section through abdomen of female.
Pl.XXVII.	Fig.66.	Frontal section through posterior portion of female abdomen.
	Fig.67.	Frontal section through posterior portion of female abdomen. Slightly ventral to preceding sections.
Pl.XXVIII.	Fig.68.	Frontal section through junction of thorax and abdomen. Male.
	Fig.69.	Frontal section through posterior end of abdomen. Male.
Pl.XXIX.	Fig.70.	Frontal section of abdomen showing region of testis. Enlarged.
	Fig.71.	Cross section of abdomen through testis.
Pl.XXX.	Fig.72.	Cross section through portion of abdomen. Enlarged.

Fig.73. Frontal section of lateral portion of abdomen. Enlarged.

Pl.XXXI. Fig.74. Sagittal section of thorax showing tracheal connection to muscles.

Fig.75. Cross section through metathorax showing repugnatory gland.

Pl.XXXII. Fig.76. Frontal section through middle of repugnatory gland.

ABBREVIATIONS OF TERMS USED

A, mandibular plate
AcGl, accessory gland
Aclp, anteclypeal plate
AcR, antecostal ridge
acs, antecostal suture
AInt, anterior intentine
an, anus
AntNv, antennal nerve
Ao, aorta
Ap, apodeme
ArCor, articular corium
as, antennal suture
Atr, atrium
Ax, axillary
AxP, axillary plate
B, maxillary plate
bl, ejaculatory reservoir
Br, brain
1Br, protocerebrum
2Br, deutocerebrum
3Br, tritocerebrum
Bs, basisternum
BsFl, basisternal flap
Btar, basitarsus
buc, buccula
C, costa
CgCls, corneagenous cells
Cin, chitinous intima
cl, clavus
Clp, clypeus
cls, claval suture
co, corium
CoeCon, circumoesophageal connective
con, interganglionic connective
Con, connexivum
coph, copulation hooks
Cor, cornea
Cr, crop
CrCls, crop cells
Cu, cubitus
Cx, coxa
CxPl, pleuro-coxal process
DDph, dorsal diaphragm
de, ductus ejaculatorius
Dgl, dorsal scent gland
dlm, dilator muscles

dlphy, dilator muscle of pharynx
dlsyr, dilator muscle of syringe
dres, duct of reservoir
DT, dorsal arm of tentorium
e, embolium
E, compound eye
Epm, epimeron
Eps, episternum
es, epistomal suture
ESh, epithelial sheath
fc, food canal
Fm, femur
For, foramen magnum
Fr, frons
FrCon, frontal ganglion connective
FrGng, frontal ganglion
Ft, adipose tissue
Fu, sternal furca
g, mandibular plate
GC, genital chamber
Ge, genae
Gng_1, prothoracic ganglion
Gng_{2+3}, pterothoracic ganglion
Grm, germarium
Gu, gula
HP, humeral plate
Hphy, hypopharynx
HyphyNv, hypopharyngeal nerves
Ht, heart
J, jugal vein
jf, jugal fold
Ju, jugum
k, sternacostal suture
K, unguifer
Lb, labium
LbNv, labial nerve
Lm, labrum
LmNv, labral nerve
lvr, lever of mandibular bristle
m, mesothoracic groove
M, media
M_1, first media
M_2, second media
M_{3+4}, third and fourth media
Mal, Malpighian tubules
mD, median dorsal muscles
Md, mandible
MdB, mandibular bristle
MdNv, mandibular nerve

Memb, membrane
MedNv, median nerve
Ment, mesenteron
mf, median furrow
Mx, maxilla
MxB, maxillary bristle
MxNv, maxillary nerve
1Nv, first lateral nerve
2Nv, second lateral nerve
3Nv, third lateral nerve
O, ocellus
Oc, occiput
Odl, common lateral oviduct
Oe, oesophagus
Odc, oviductus communis
OPdcl, ocellar pedicel
Opl, optic lobe
os, ostiole
osperi, ostiolar peritreme
Ost, ostia
Ov, ovaries
Ovl, ovarioles
P, pistill
Pa, postalare
Par, parapside
Pc, anterior precosta
Pcls, pericardial cells
Pcu, postcubitus
Pdcl, pedicel
Phy, pharynx
PInt, posterior intestine
Pl, pleuron
PlR, pleural ridge
PlS, pleural suture
pmdb, protractor muscle of mandible
$pmxb_1$, first protractor muscle of maxilla
$pmxb_2$, second protractor muscle of maxilla
Proc, proctodaeum
ps, penis
Prsc, prescutum
Pscl, postscutellum
PscS, prescutal suture
PSh, peritoneal sheath
PT, posterior arm of tentorium
Ptar, pretarsus
Pv, pulvillus
Pvent, proventriculus
PVLv, pyloric valve
R, radius

ra, posterior arm of mandibular bristle
Rect, rectum
Res, reservoir
rj, ring joint
Rm, remigium
$rmdb_1$, first retractor muscle of mandibular
$rmdb_2$, second retractor muscle of mandibular
$rmdb_3$, third retractor muscle of mandible
rmxb, retractor muscle of maxillary bristle
RNv, recurrent nerve
sc, salivary canal
Sc, subcosta
Scl, scutellum
Scp, scape
Sct, scutum
Set, tactile setae
Sgl, scent gland
Sl, sternellum
Sld, salivary duct
SlGl, salivary gland
sm, salivary meatus
SoeGng, suboesophageal ganglion
Sp, spiracle
Spt, spermatheca
Stom, stomodaeum
Syr, salivary syringe
SVlv, stomodaeal valve
T, tergum
Tar, tarsus
Tar, atrsomere
Tb, tibia
Tes, testes
TF, terminal filament
tr, tracheole
Tr, trochanter
ts, transverse suture
TSt, tergosternal muscle
un, lateral claw
Utr, unguitractor plate
v, valve
V, vannal vein
1V, first vannal vein
2V, second vannal vein
Vd, vasa deferentia
vda, vectis dorsualis anterior
vdp, vectis dorsualis posterior
Vent, ventriculus
ves, vestibule
vf, vannal fold

Vms, valvular retractor muscle
Vn, vannus
Vx, vertex

I, zone of growth
II, maturation zone
III, zone of transformation

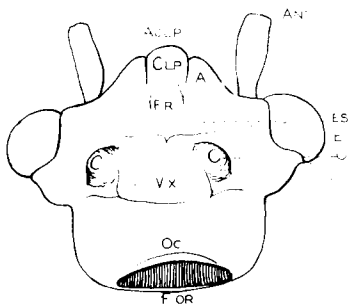


FIG. 1

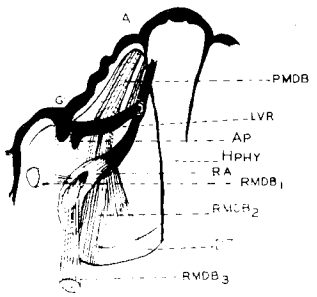


FIG. 2

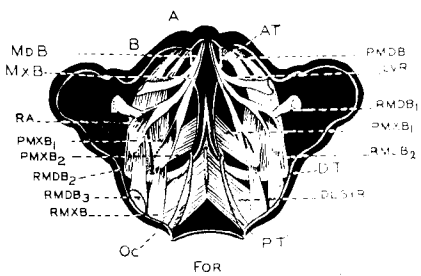


FIG. 3

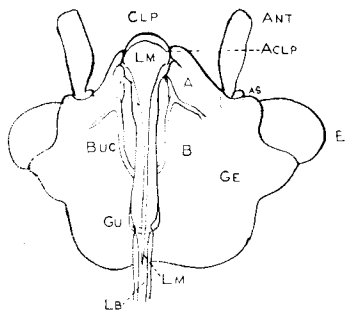


FIG. 4

PLATE I

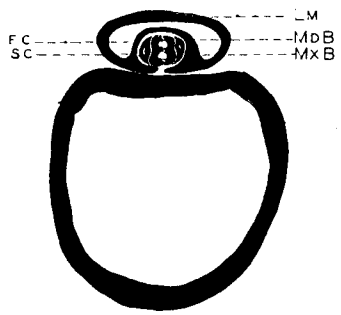


FIG. 5

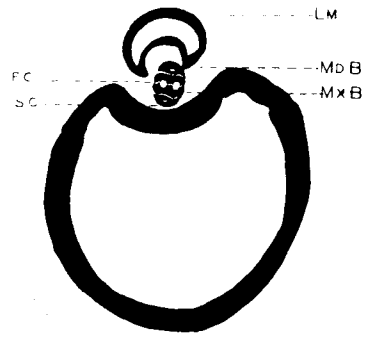


FIG. 6

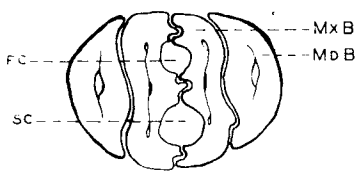


FIG. 7

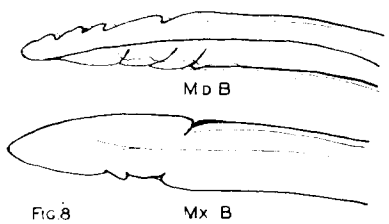


FIG. 8

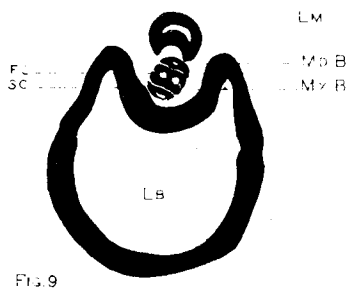


FIG. 9

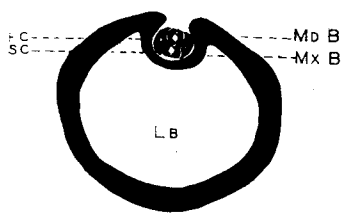


FIG. 10

PLATE II

FIG. 11

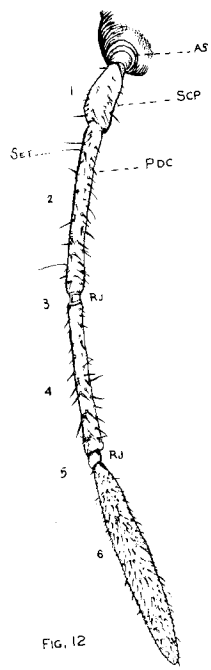


FIG. 12

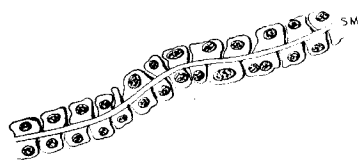


FIG. 13

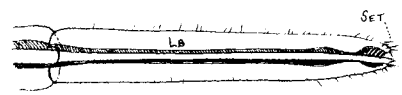


FIG. 14

PLATE III

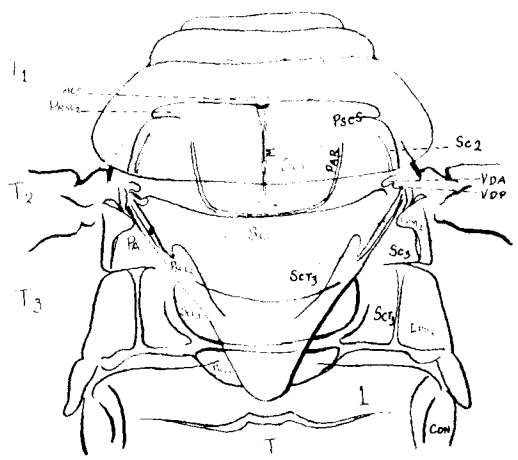


FIG.15

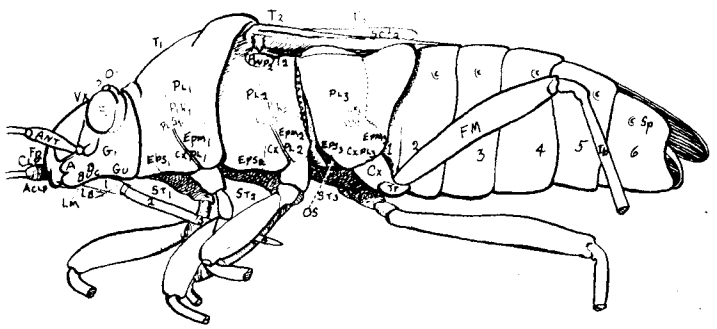


FIG. 16

PLATE IV

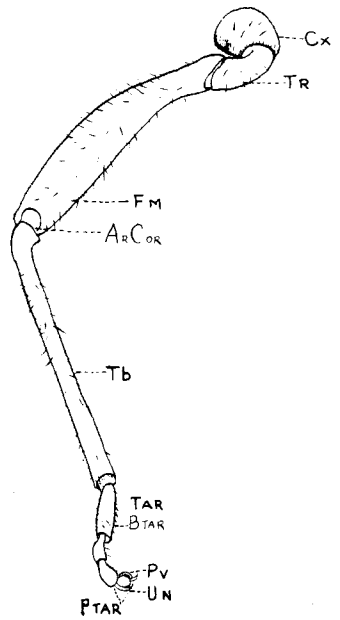


Fig. 17

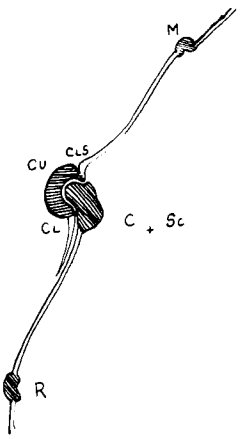


Fig. 18

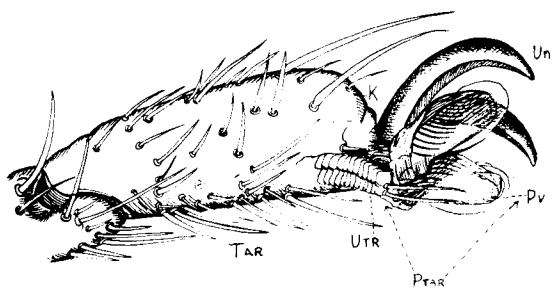


Fig. 19

PLATE V

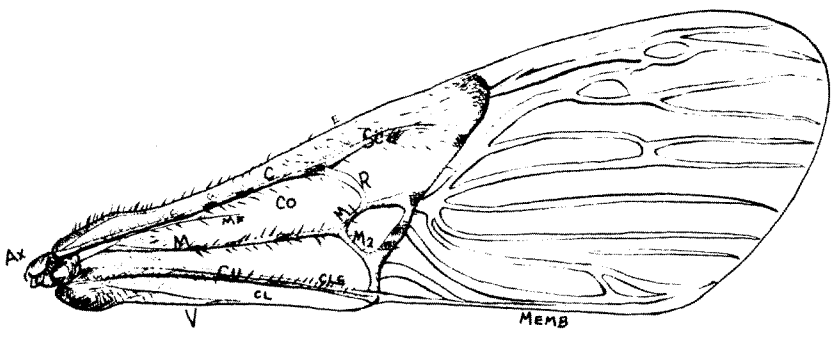


FIG. 20

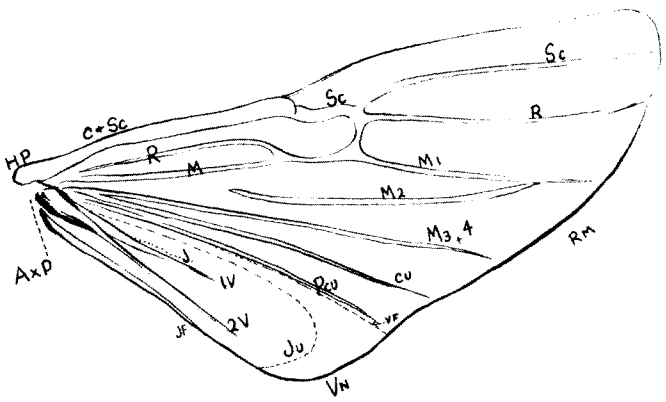


FIG. 21

PLATE VI

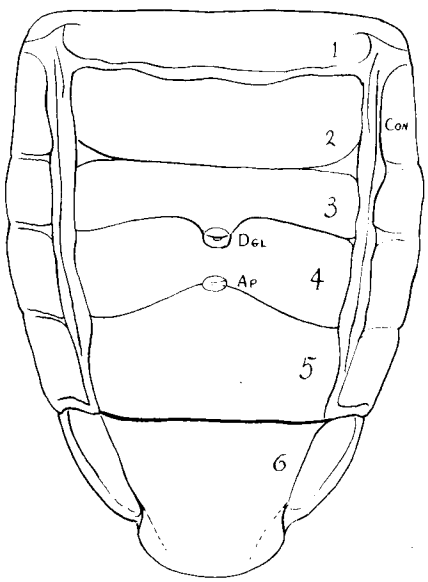


FIG. 22

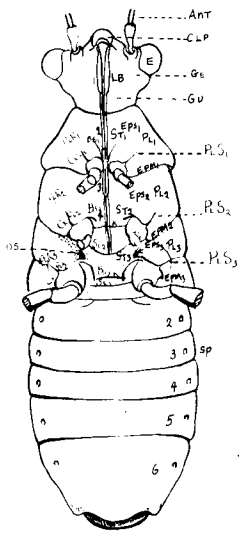


FIG. 23

PLATE VII

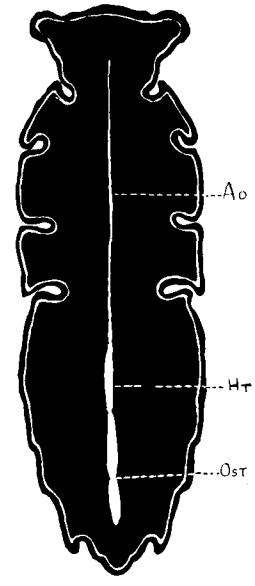


FIG. 24

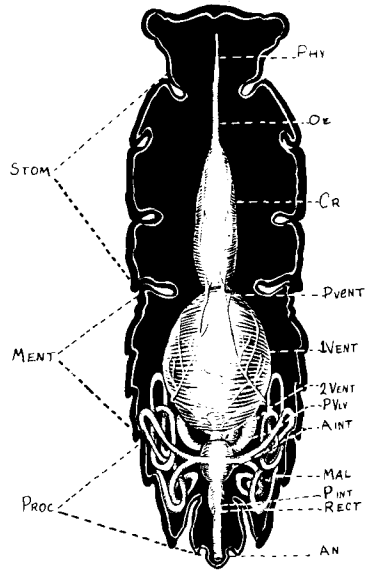
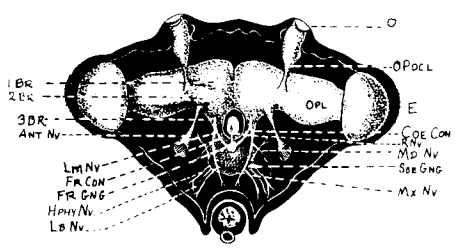


FIG. 25

PLATE VIII

FIG. 26



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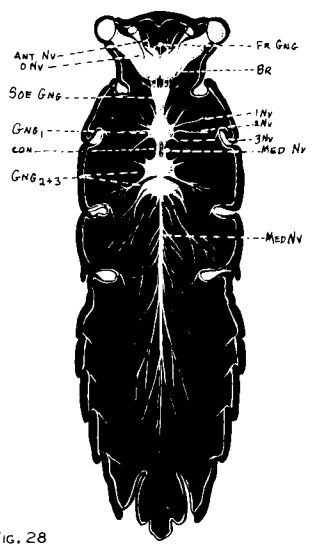
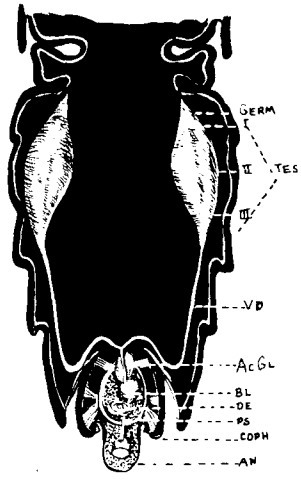


FIG. 28

PLATE IX



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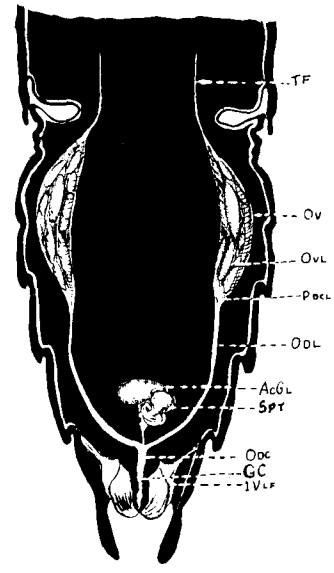


FIG. 30

PLATE X

FIG. 31

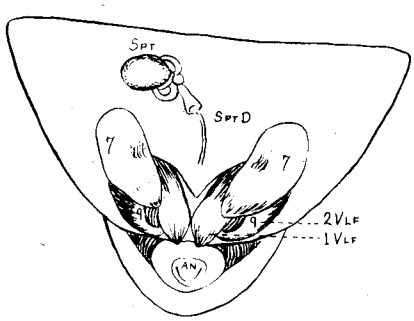


FIG. 32

PLATE XI

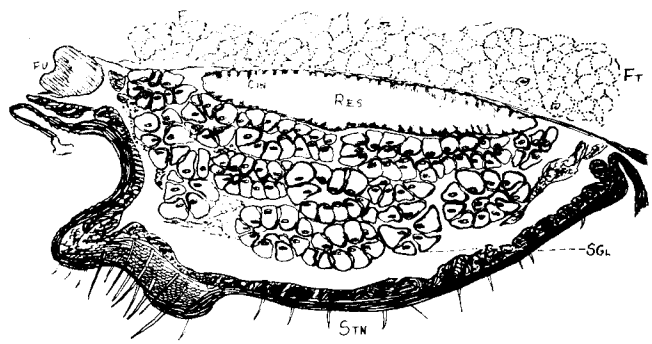
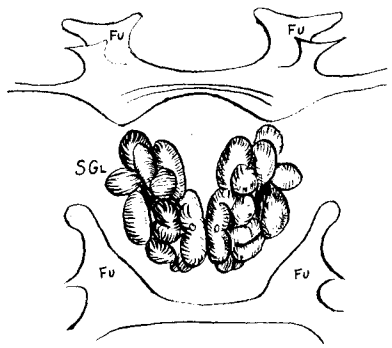


FIG. 33



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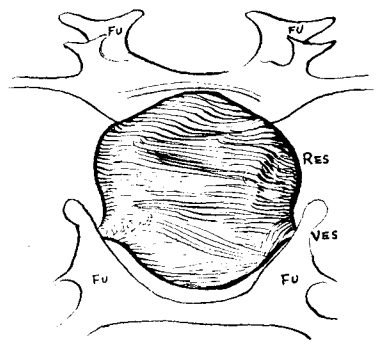
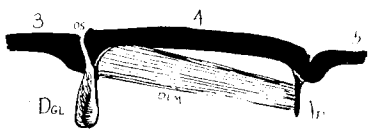


FIG. 35

PLATE XII



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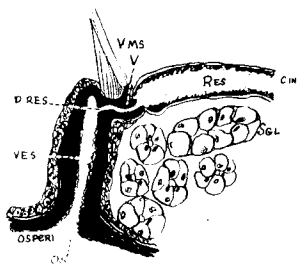

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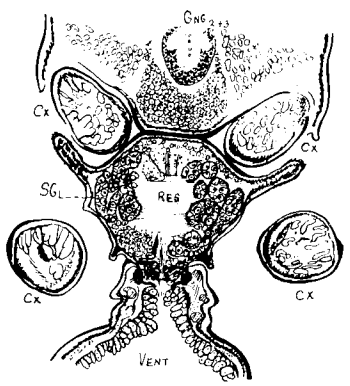


FIG. 38

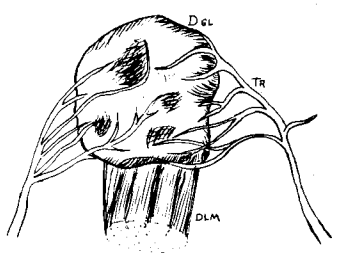


FIG. 39

PLATE XIII

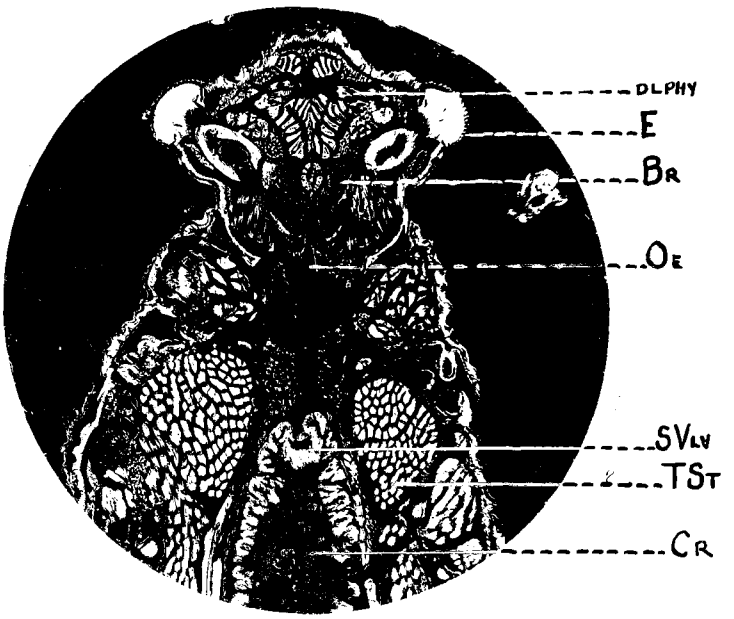


Fig. 40

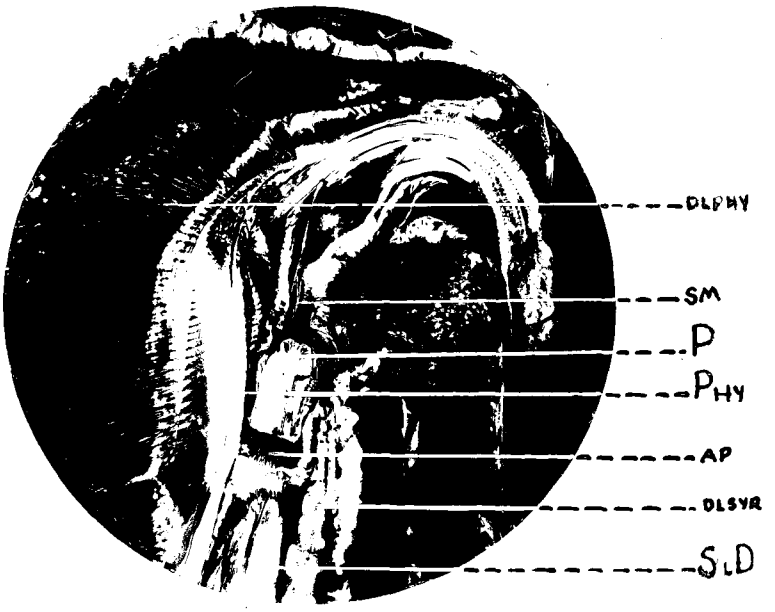


Fig. 41

PLATE XIV

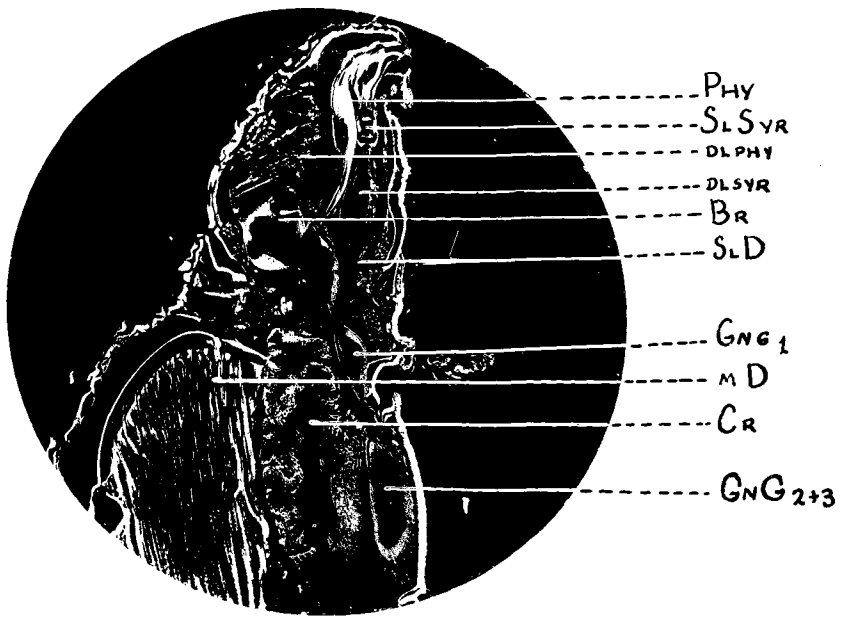


Fig. 42

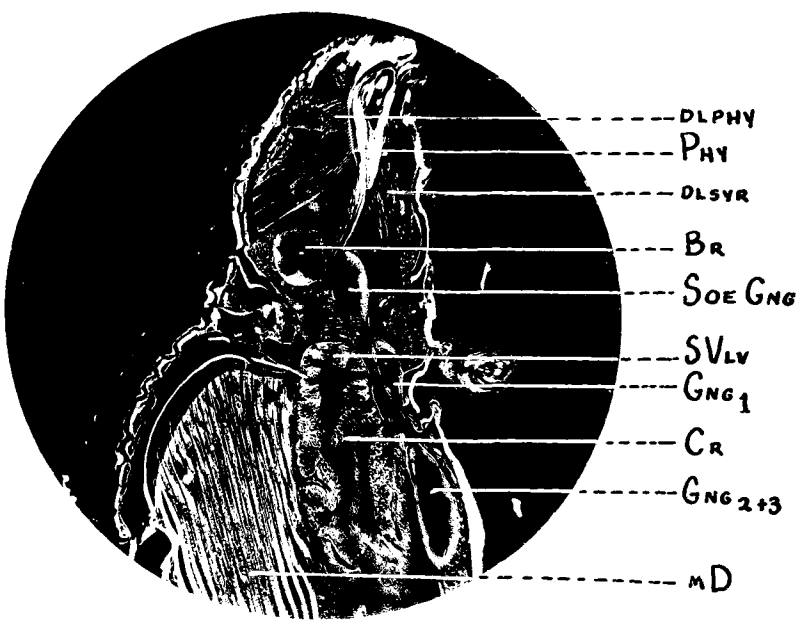
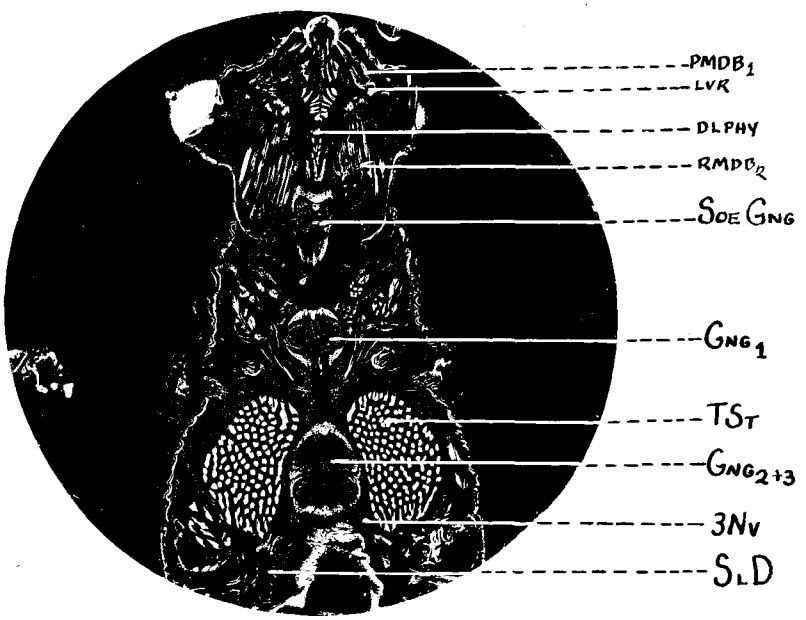


PLATE XV



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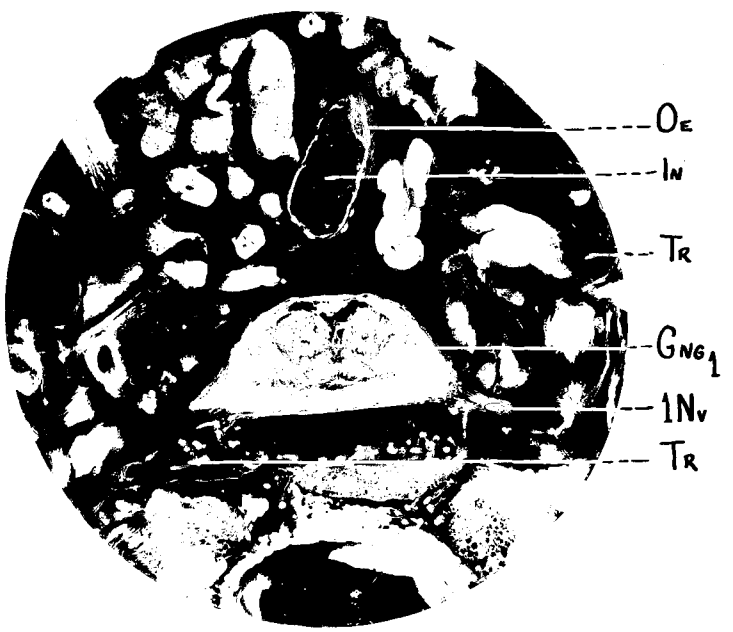


Fig. 45

PLATE XVI

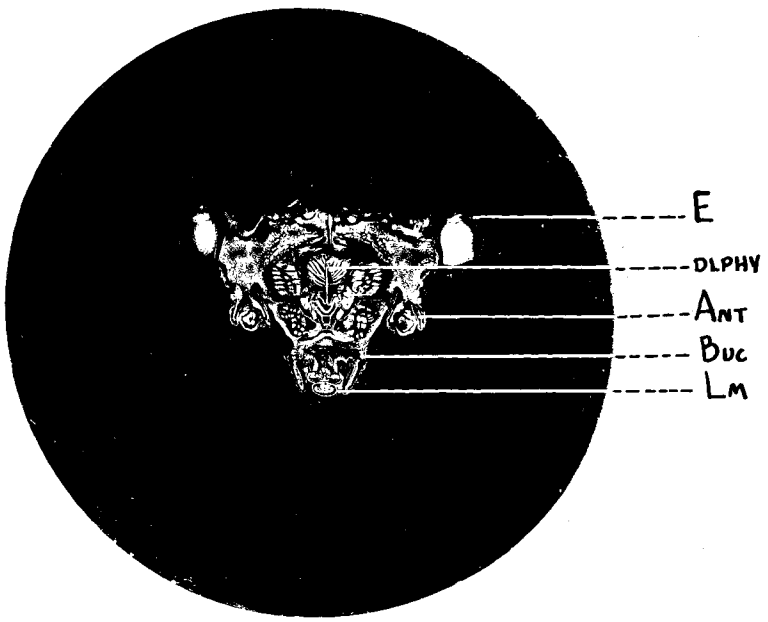


Fig. 46

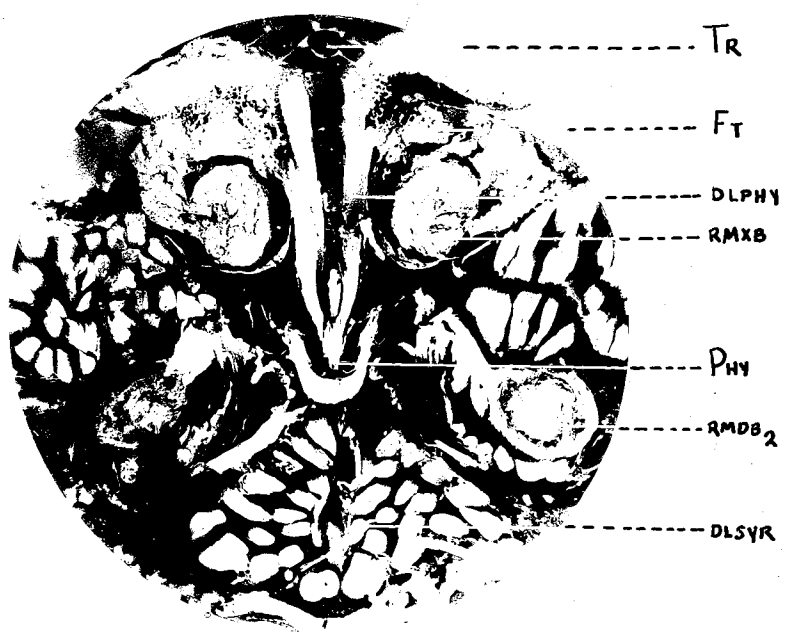
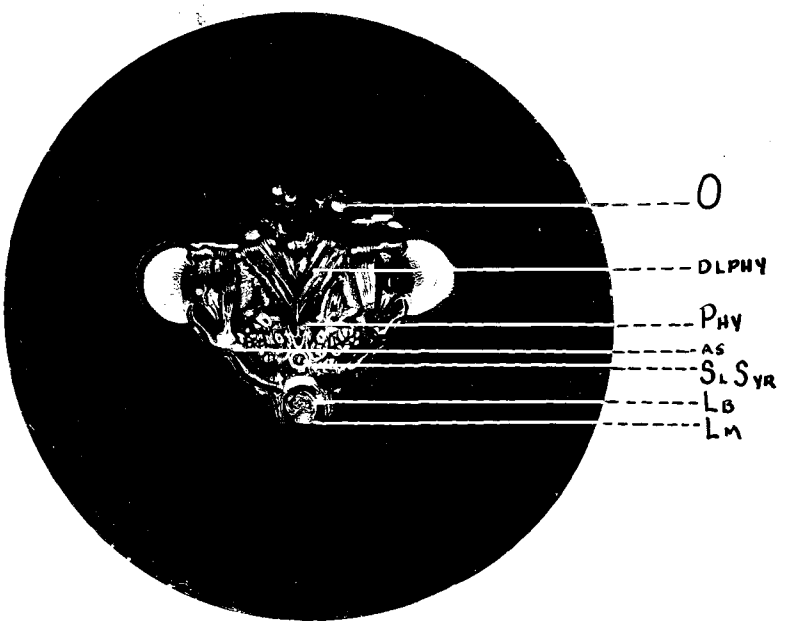


Fig. 47

PLATE XVII



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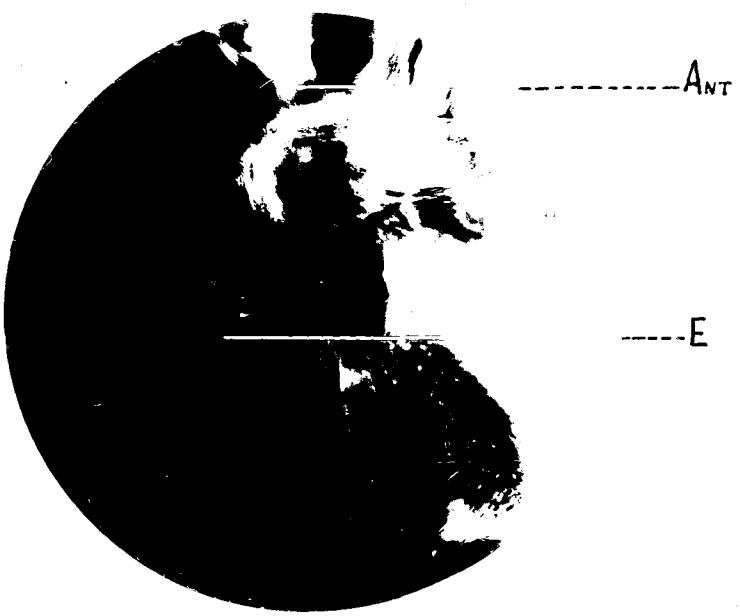


Fig. 49

PLATE XVIII

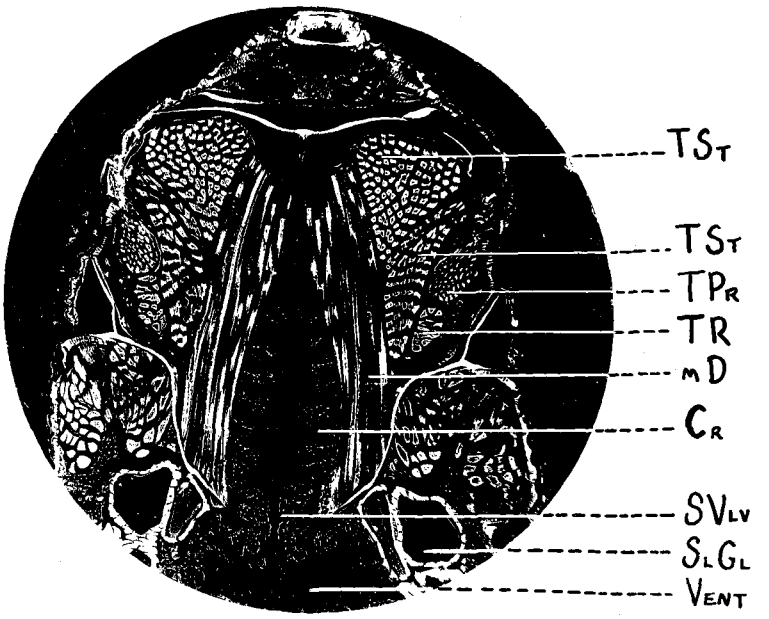


Fig. 50

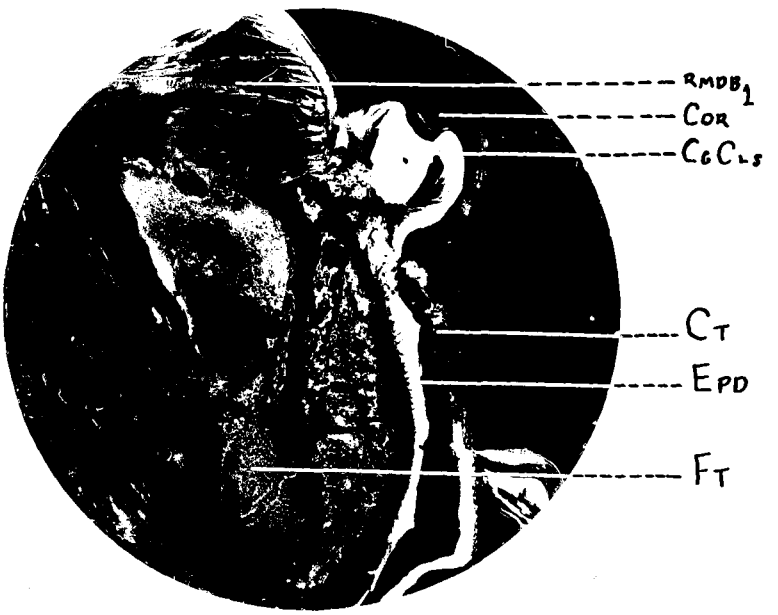
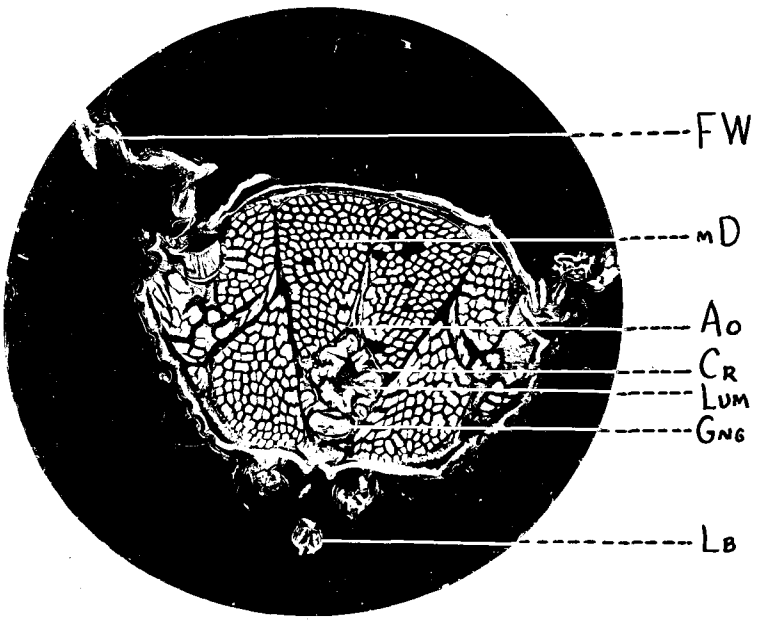


Fig. 51

PLATE XIX



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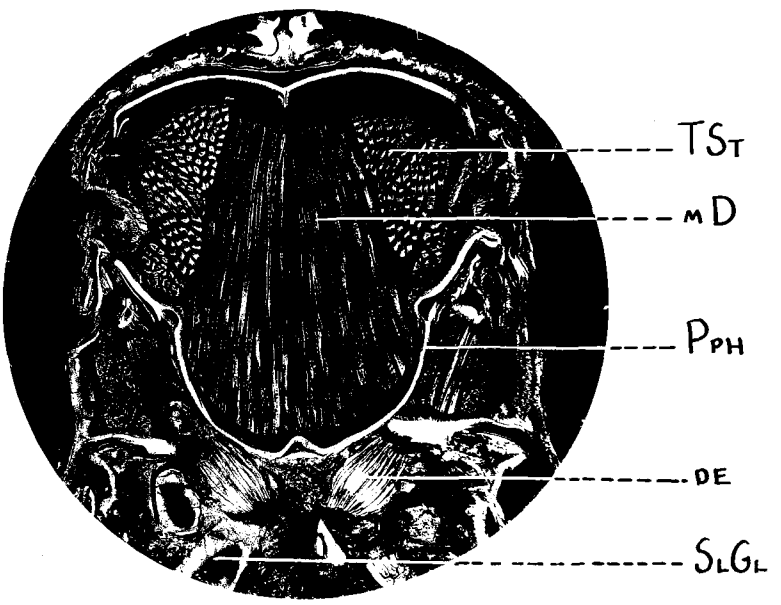

Fig. 53

PLATE XX

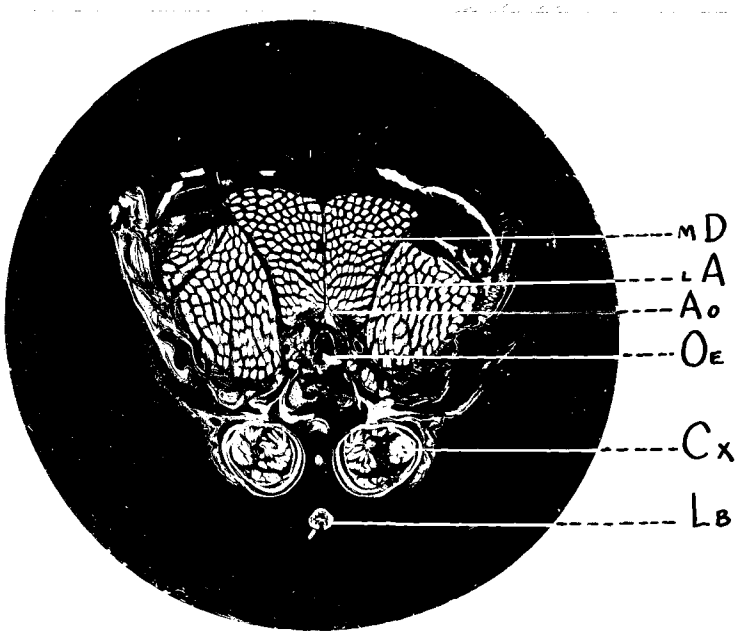

Fig. 54

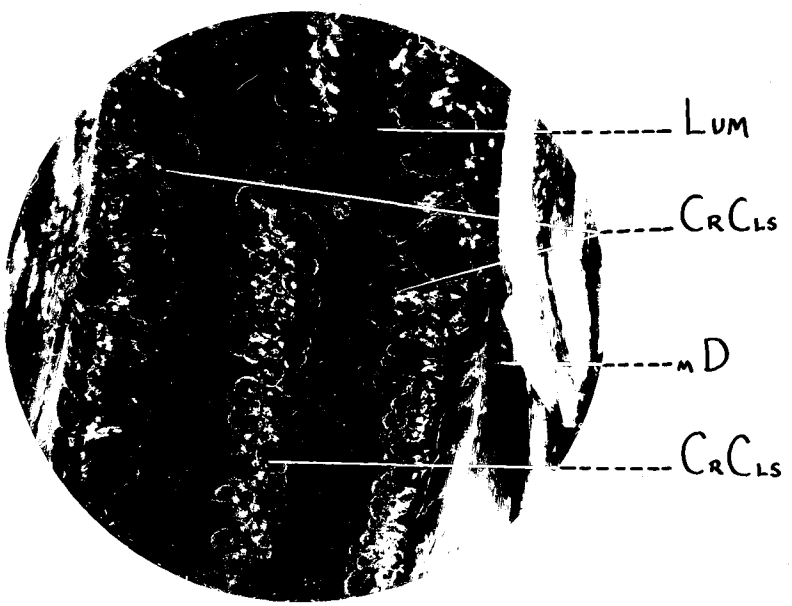

Fig. 55

PLATE XXI

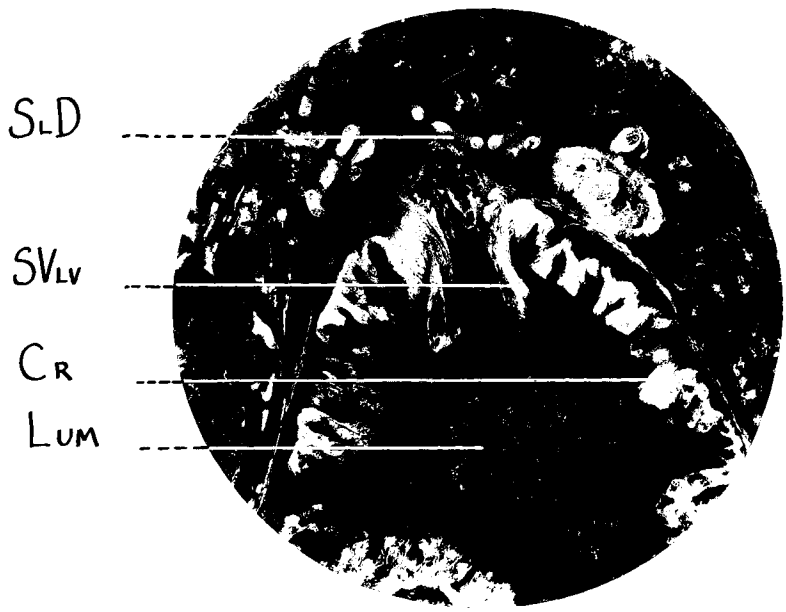

Fig. 56

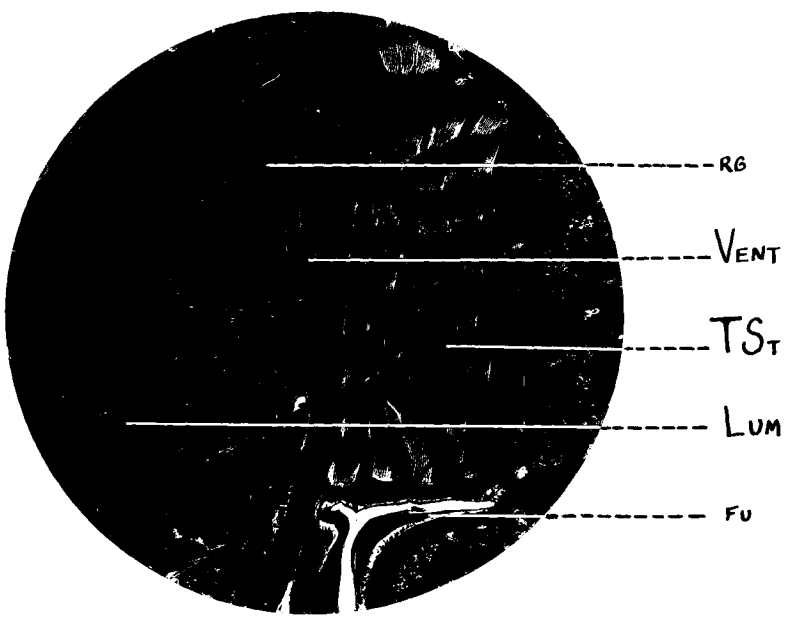

Fig. 57

PLATE XXII

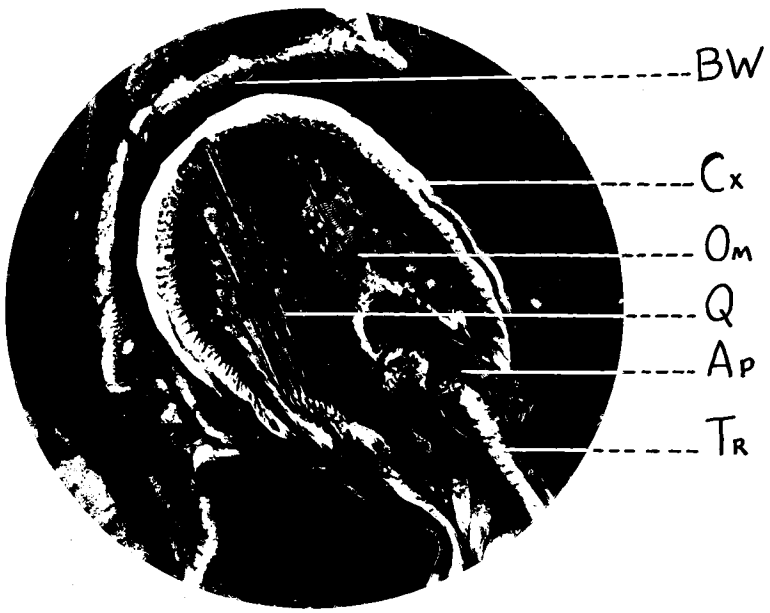

Fig. 58

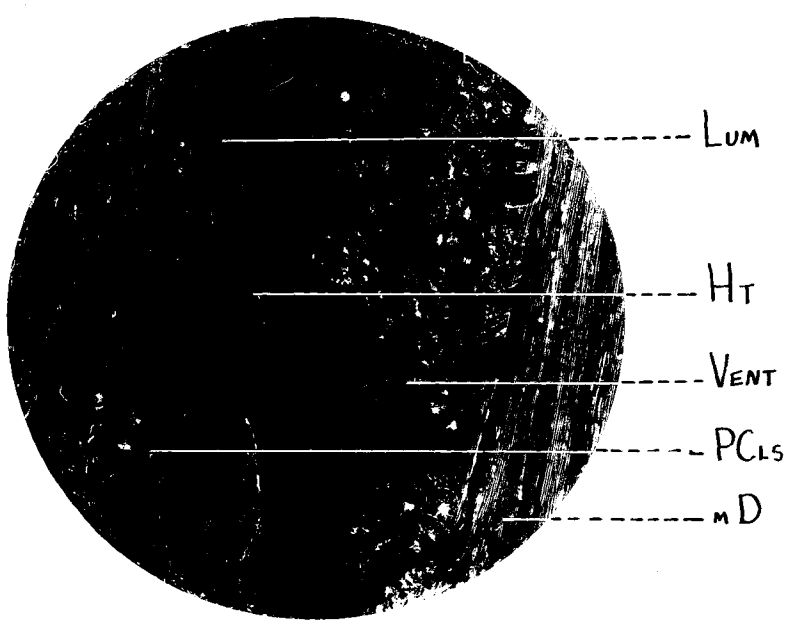

Fig. 59

PLATE XXIII

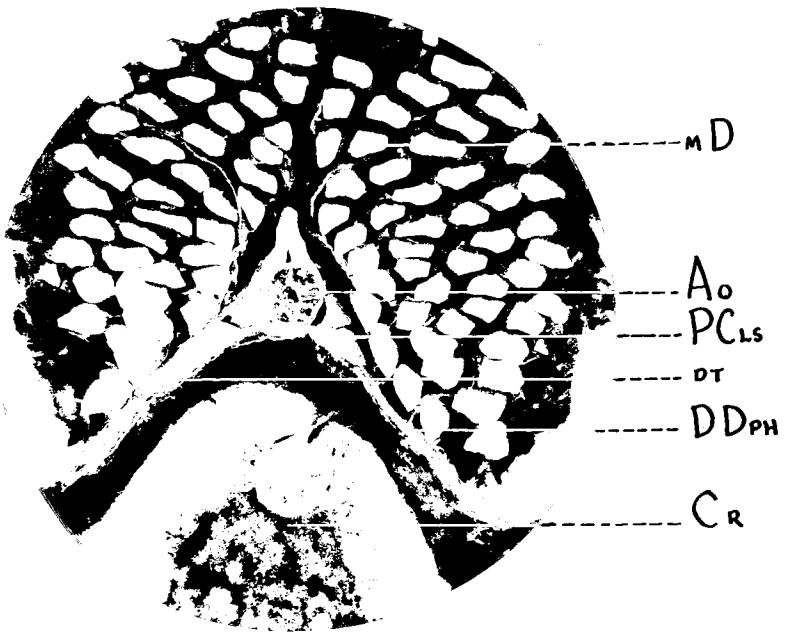

Fig. 60

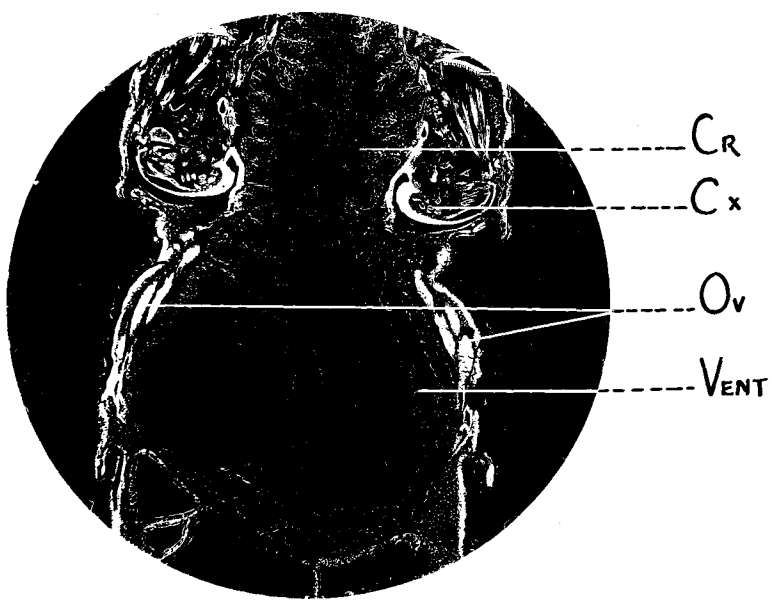

Fig. 61

PLATE XXIV

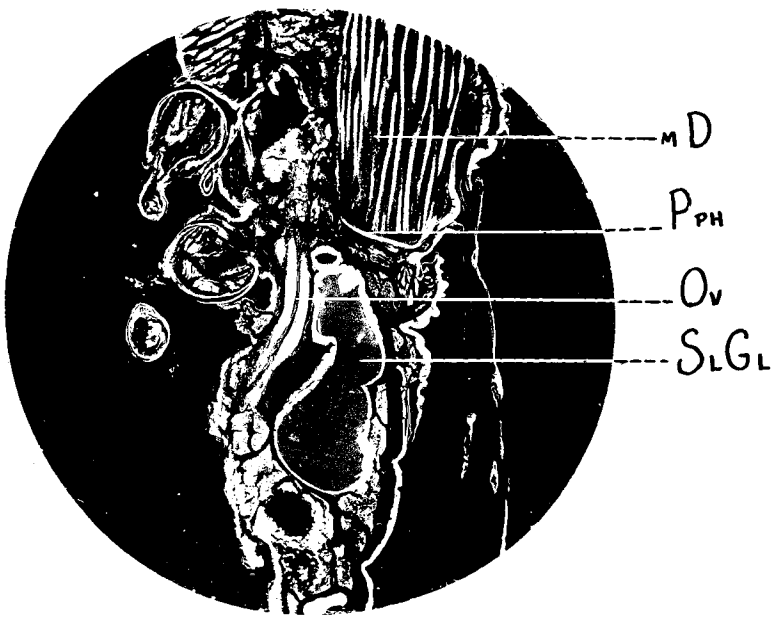

Fig. 62

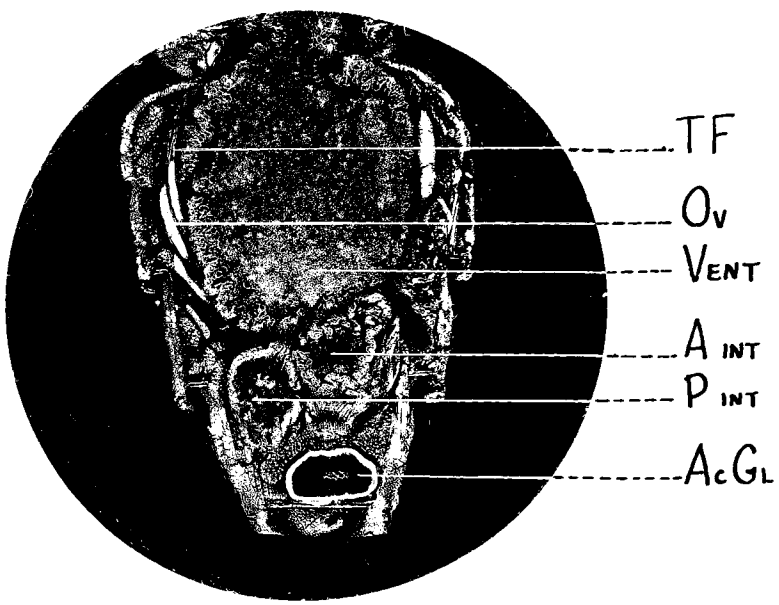

Fig. 63

PLATE XXV

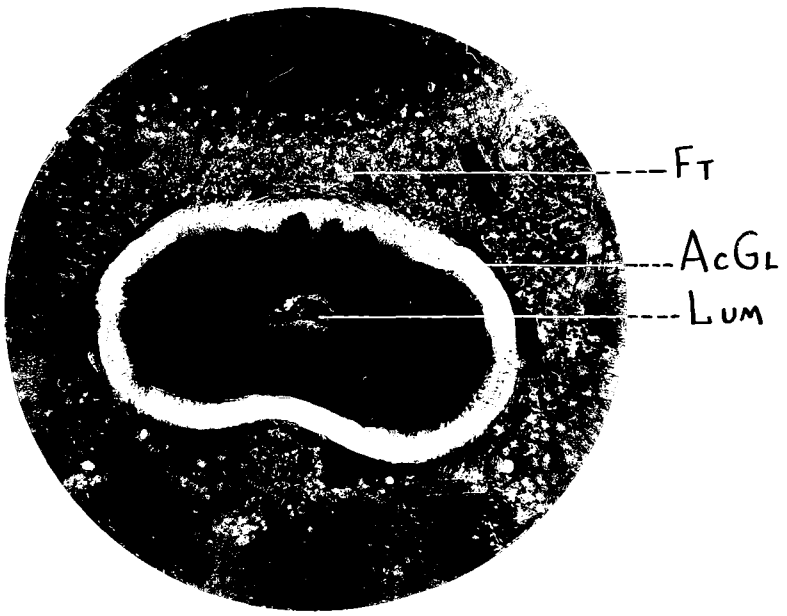

Fig. 64

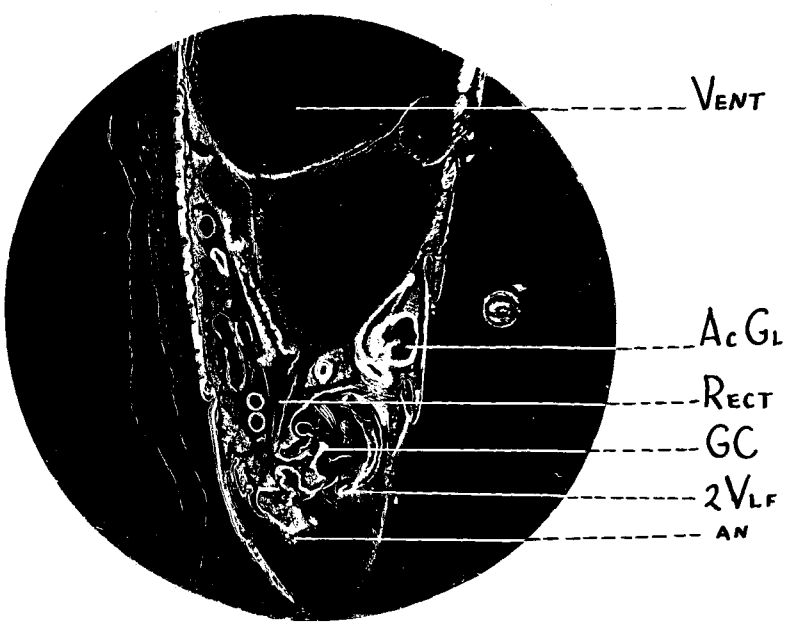

Fig. 65

PLATE XXVI

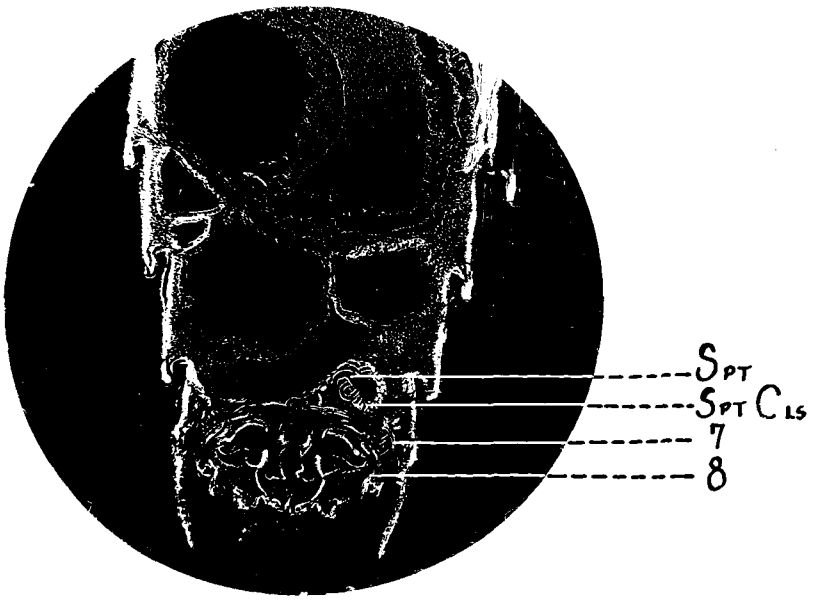

Fig. 66

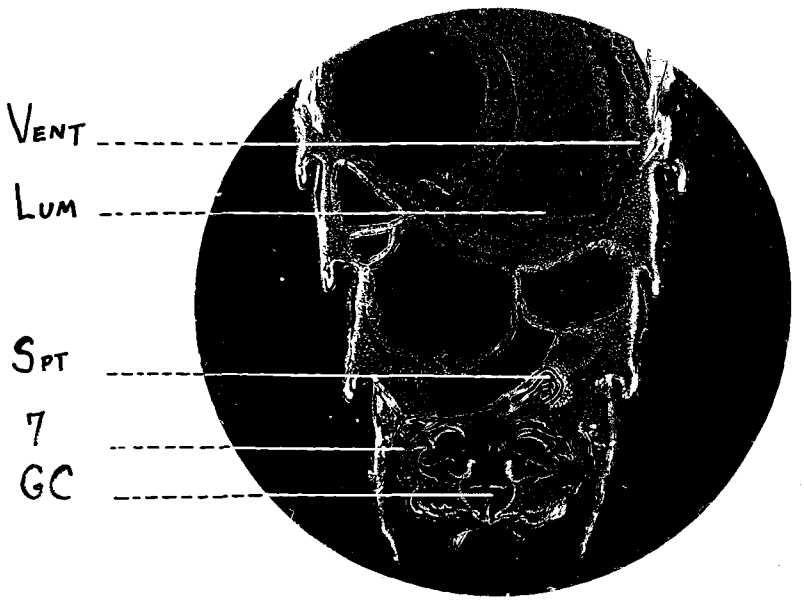

Fig. 67

PLATE XXVII

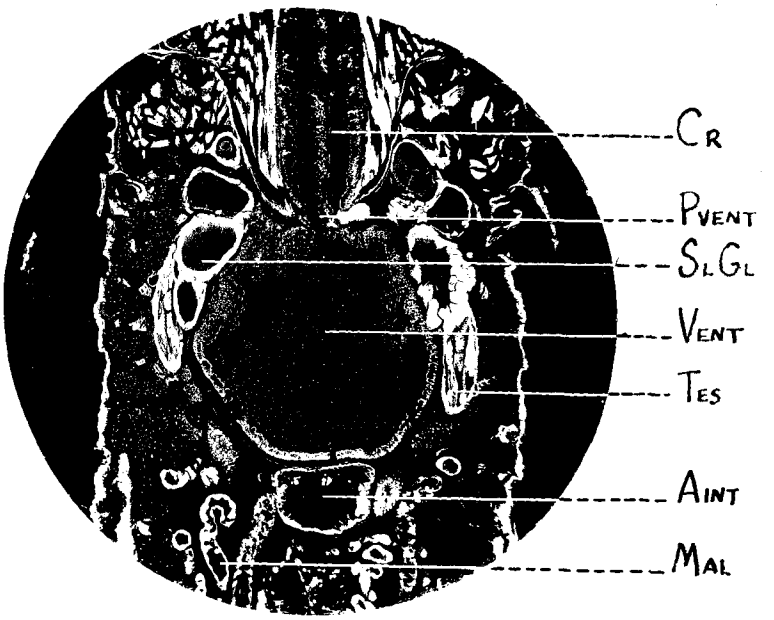

Fig. 68

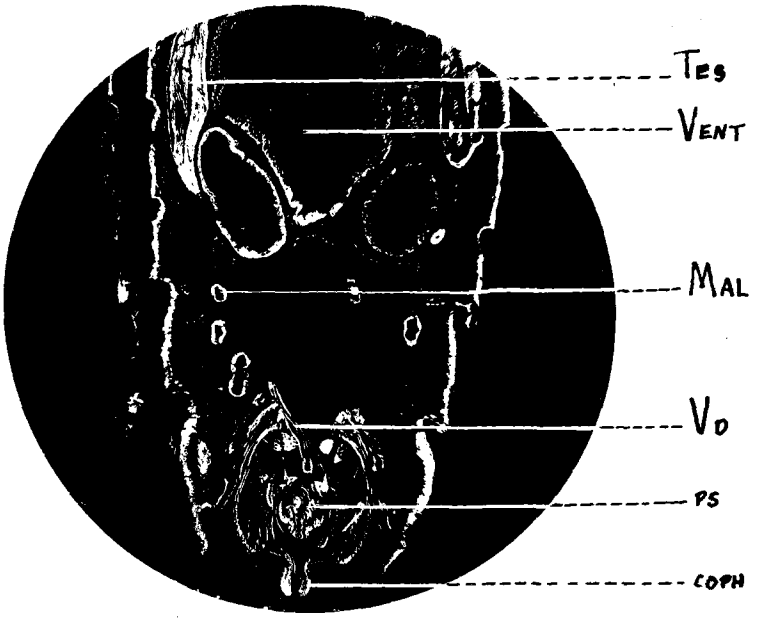

Fig. 69

PLATE XXVIII

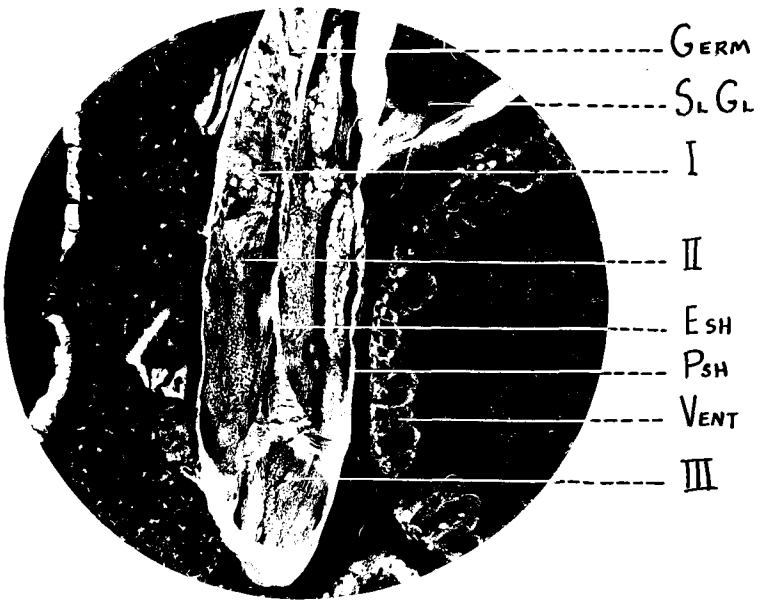

Fig. 70

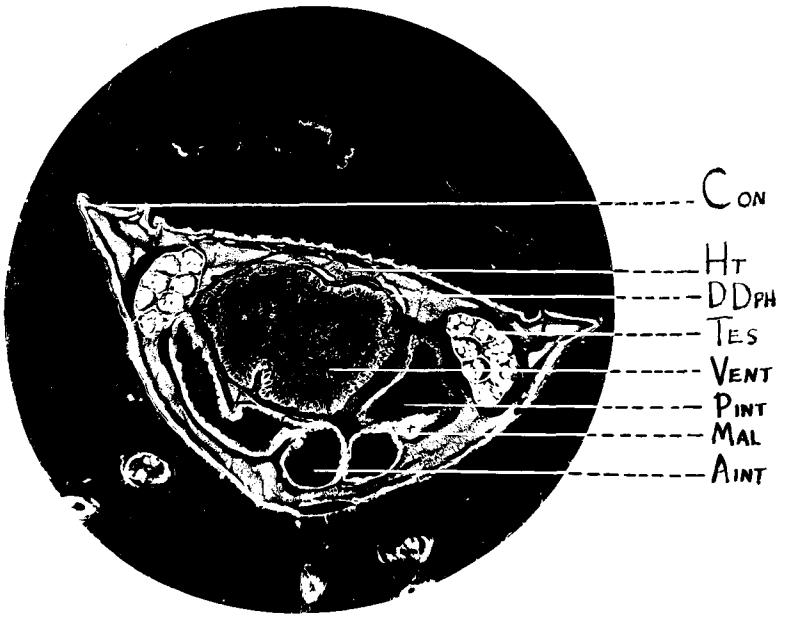

Fig. 71

PLATE XXIX

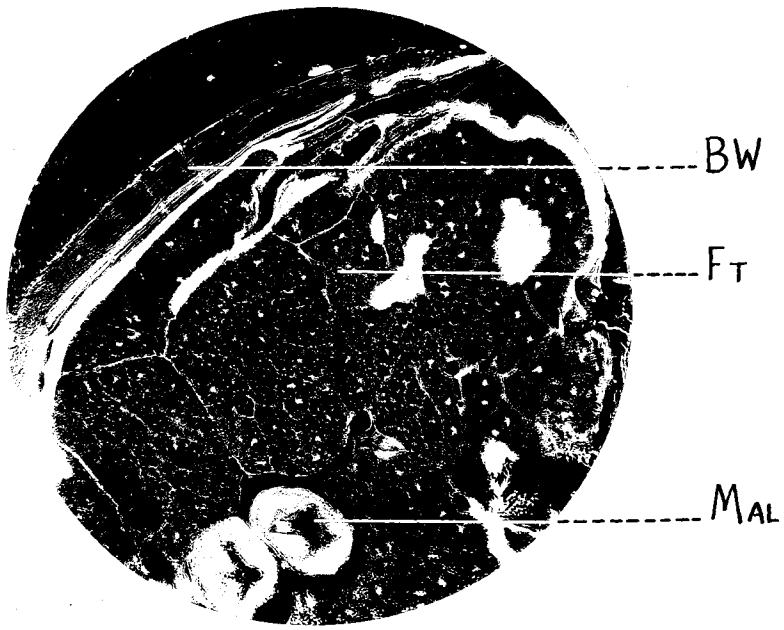

Fig. 72

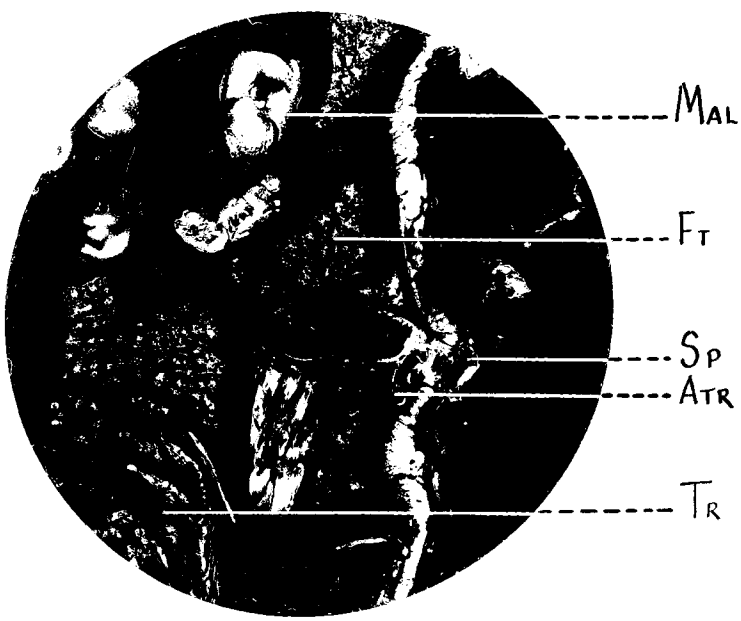

Fig. 73

PLATE XXX

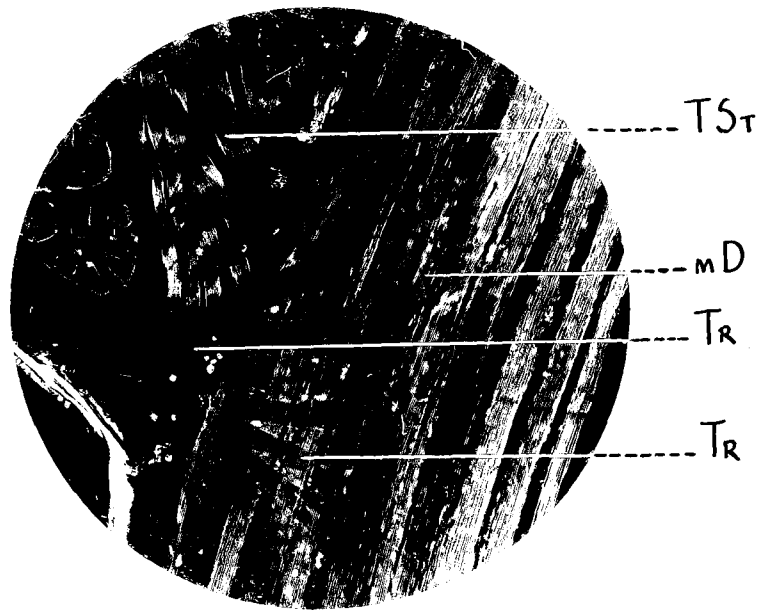

Fig. 74

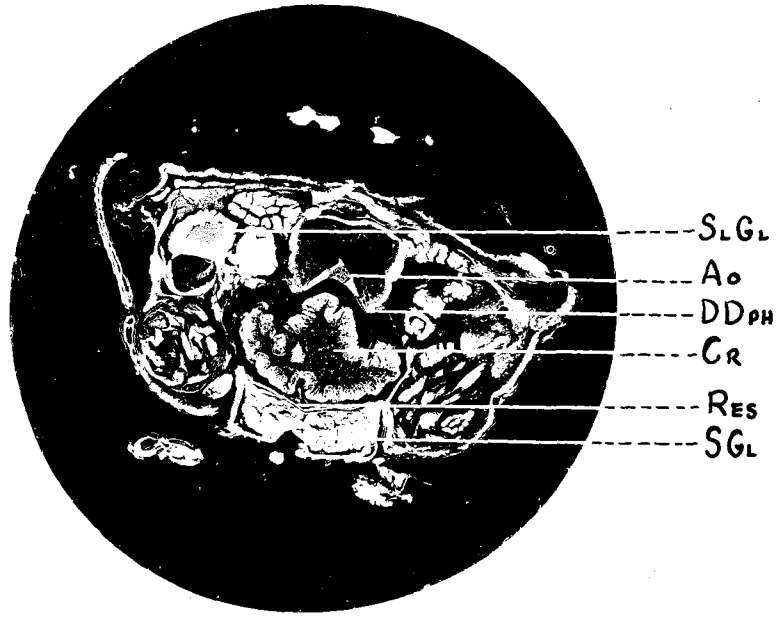

Fig. 75

PLATE XXXI

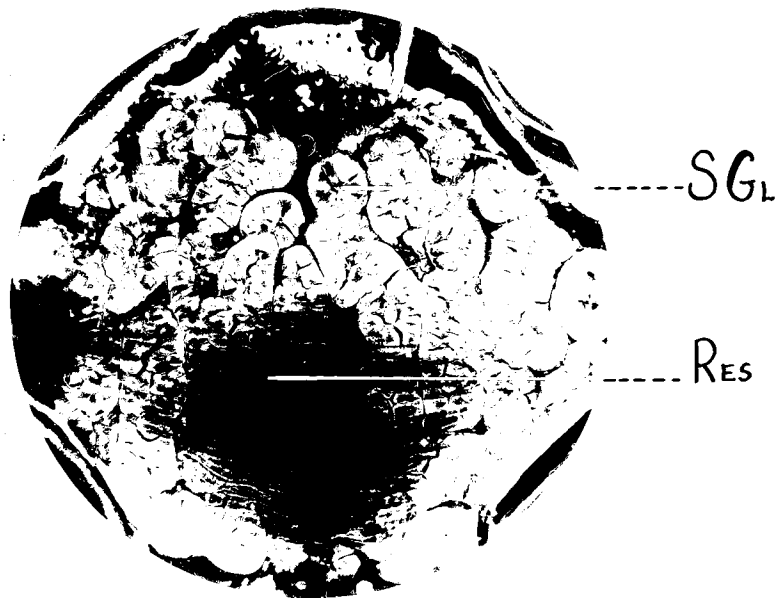

Fig. 76

PLATE XXXII